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INDEX.

NOTE.—Illustrated articles are marked with an asterisk (*) following the title.

ARTICLES.

PARAGRAPHS.

DICTIONARY.

LITERATURE.

IMPROVED APPARATUS.

EDITORIAL.

OBITUARY.

EDUCATIONAL.

PATENTS.

QUERIES AND ANSWERS.

CORRESPONDENCE.

MARINE ENGINEERING.

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PREPARATORY SKETCH OF THE NEW U. S. PROTECTED CRUISERS OF THE DENVER CLASS.

CHARACTERISTICS OF THE NEW PROTECTED CRUISERS OF THE DENVER CLASS.

Under the provisions of the Naval Appropriation bill passed by the last Congress, six new cruisers for the United States Navy will soon be under construction at various yards on the coasts. Through the courtesy of the naval authorities we are able here to present to our readers the chief characteristics of these interesting vessels. Their names have already been selected, and they will be known, respectively, as the *Denver*, *Des Moines*, *Chattanooga*, *Galveston*, *Tacoma* and *Cleveland*. In one respect these ships will be a radical departure from previous practice in the United States Navy, as they will be sheathed and coppered; and in other respects they will, of course, be strictly up to date and the equal, if not the superior, of anything of their size afloat. These new vessels are now referred to as belonging to the *Denver* class, this being a ready aid to the memory in recalling the dimensions, etc., of any one of the six when they are mentioned.

For many years Chief Constructor Hichborn, U. S. N., stood almost alone in his advocacy of sheathing for ships' bottoms, but persistent argument, combined with many object lessons from the reports of our ships in service, which tended to prove the statements in favor of sheathing, have at last overcome the strong prejudice against it, and all of the twelve ships authorized by the last Congress—three first-class battleships, three first-class armored cruisers, and the six protected cruisers here described—are to be sheathed and coppered.

On account of the Congressional limitation of the price which the Department may pay for armor, and the improbability of being able to get any armor at that price, the six ships of the *Denver* class are the only vessels for which contracts can be made without further action by Congress. Designs for these ships are now being rapidly perfected by the Bureau of Construction and Repair. They will be vessels of about the size of the *Raleigh* and *Cincinnati*, but improved and modernized. The latter ships were designed at the time when the craze for speed at all costs reached its maximum, and to attain this extreme speed, which it will be noted could only be maintained for a few weeks after they were docked and cleaned, on account of their rapidly fouling unsheathed bottoms, too many other qualities were sacrificed, and they are now being altered to remedy this defect. The *Denver* and her sister ships are designed for a speed of 16 1-2 knots, but will only make 17 knots when pushed, while the *Raleigh* and *Cincinnati* were designed for a speed of 19 knots. The former will be able to maintain their designed speed practically indefinitely, while the latter in actual service could scarcely maintain a speed of 15 knots, and that with an excessive consumption of coal. The horse power required in the new designs is 4,500 as compared with 10,000 in the *Raleigh* and *Cincinnati*, which means less than half the weight of propelling machinery.

The guns will all be designed for smokeless powder, and the 5-in. guns will be more effective than the old type of 6-in guns. Eight of them will be mounted on the main deck in recessed ports: the four forward ones having a range from right forward to 60 degrees abaft the beam, and the four after ones from right aft to 60 degrees before the beam. The two remaining 5-in. guns will be mounted behind shields on the spar deck: one forward and one aft. Four 6-pounders will be mounted on the main deck: two forward and two amidship, and four more on the spar deck. The two 1-pounder guns will be mounted aft on the main deck, and the Colt machine guns on the top of the hammock berthing amidship.

The general dimensions and features of the *Denver* and class will be as follows:

Length on load water line	292 ft.
Length, extreme	308 ft. 2 in.
Breadth, extreme, about	43 ft.
Mean draft at trial displacement; two-thirds coal, ammunition and stores	15 ft. 6 in.
Extreme draft fully loaded	16 ft. 8 in.
Trial displacement, about	3,100 tons.
Full load displacement, about	3,400 "
Coal carried on trial	470 "
Total bunker capacity, not less than	700 "
Speed on trial	16 1-2 knots.
Type of engines: Vertical inverted, four-cylinder, triple-expansion. Estimated indicated horse power	4,500
Type of boilers: Water-tube. Number of boilers	6

MAIN BATTERY.

Ten 5-in. 50-cal. B. L. R. F. guns.

AUXILIARY BATTERY.

Eight 6-pounder R. F. guns.
Two 1-pounder R. F. guns.
Four Colt machine guns.

Sail area, about ....6,000 sq. ft.

The coal capacity of these ships with bunkers full (700 tons) is sufficient to give them a radius of action at full speed of about 2,600 miles. At the most economical rate of steaming, probably in the neighborhood of 10 knots per hour, they will be able to steam about 9,800 miles without recoaling, or more than sufficient to take them from San Francisco to Manila. The ammunition supply will be large, as it should be to make rapid-fire guns effective. For each of the 5-in. guns they will carry 250 rounds, and for each of the 6-pounders, 500 rounds.

The wood material used in the construction of the hulls will be reduced to a minimum. All the bulkheads on the gun and berth decks will be of metal. Each vessel will be fitted with a pilot house on the spar deck built entirely of non-magnetic metal. Where it is necessary to use wood for any purpose, it will be treated with the electric fireproofing process before being worked. A watertight deck covered with 1-2 in. plate will be worked from stem to stern, the sides sloping down to 3 ft. below the water line, and the flat or midship portion rising 18 in. above the water line. This will be on the line of the berth deck for the greater part of the length, but toward the ends it will slope down. On top of the watertight deck at the sides a belt of obdurating material will be worked, covering the water line for the whole length of the ship. All of the propelling machinery, steering gear and magazines will be below the watertight deck. The rig will be two-masted schooner, with signal yards on the foremast.

Each vessel will have two searchlights, an electric signaling system, and a complete installation of electric lights. The blowers for ventilation and deck winches will be operated by electricity.

FROM FURNACE TO PROPELLER—A HISTORY OF THE ENERGY LOSSES WHICH OCCUR ON THE WAY.

BY EDMUND LEAVENWORTH.

The fireman wields the shovel—the propeller turns and the ship speeds on her course. Here we have a cause and its effect standing, respectively, at the head and foot of a long series of operations. With the history of these operations the marine engineer is most deeply concerned. Let us trace then some of the steps which lead from the fireman and the coal which he throws on the fire, to the propeller and the ship which it urges through the water.

We must, at the start, clearly understand that it is with *energy* and *work* and the history of their journey from the coal to the propeller that we are concerned. These words energy and work, or more especially the first, may suggest mechanics and mathematics, but we shall have small use for either in this discussion, except in the most simple form. In any event, energy is simply the name of the capacity for doing work, and the engineer, if any one, should surely be acquainted with such a capacity in any and all its forms. Thus a lump of coal represents simply a certain amount of energy, or the capacity to do a certain amount of work, and the whole engineer's equipment on board ship exists simply in order that as much as possible of the energy may actually be converted into the desired work of propelling the ship. Unfortunately this result, so easy to state in words, requires a long series of transformations or changes of form, and transportations or changes of place, in all of which more or less is lost by the way. In fact, the engineer's life is one long struggle against the tendency of energy to escape in some way or other, and so to avoid the transformation into useful work. Energy and work are, in fact, such peculiar commodities that it is next to impossible to effect any change either of form or place without some loss, and quite impossible to effect certain of the changes which are necessary without very serious loss. It is the history of these changes and losses which befall the energy on its way from the coal to the propeller that we are now to examine.

Let us first understand that coal is not energy, neither does it by itself possess energy. It is simply a substance whose union with oxygen results in *liberating* energy—from where we will not here ask. That is another story. It is enough for the engineer to know that when coal unites with oxygen, or *burns*, as we commonly say, energy is liberated in the form of heat, and it is then his duty to use it as best he may. The burning or combustion is accomplished in the boiler furnaces, where the oxygen supplied by the air unites with the carbon and hydrogen in the fuel, and heat energy is set free. Suppose now that we start with one pound of good coal. Then experience shows us that if this pound of coal were perfectly and completely burned, and so all the heat available from it were liberated, there would be about 14,000 heat units; that is, 14,000 times as much as the heat required to raise one pound of water one degree, or, more exactly, from 62° to 63° Fah. Now, let us call this amount of heat 100 per cent, and represent it by the rectangle *ABCE* in the diagram on page 5. This amount we must then consider as our total available energy, our entire stock in trade for producing the propulsion of the ship. It is evident then that the first step should be the complete combustion of the fuel, for if it is not complete a corresponding loss will result. If the energy is not liberated it can never be used. If it is lost here it can never be regained. As a matter of fact, however, it is impossible to obtain absolutely complete combustion, and it is just here that the first loss comes in. A little of the fuel may fall unburned through the grate into the ashpit. A little in the form of dust and small bits may be carried by a strong draft, either unburnt or only partially burnt, through into the tubes, uptakes or funnel. Still another small portion may escape as smoke, which consists almost entirely of very fine particles of unburnt carbon formed from the gases which are distilled away from the coal in the process of combustion. Still another portion of these gases may escape entirely unchanged and unconsumed. Again, another portion of the energy may escape with a particular gas containing partially burned carbon. Chemistry teaches us that carbon and oxygen in burning may unite in two ways. One of them forms what is called *carbon monoxide*, and gives only about 4,450 heat units per pound of carbon. The other forms what is called *carbon* dioxide, and gives 14,500 heat units per pound of carbon. Hence whatever carbon escapes in the form of carbon monoxide is only partly burned, and we may consider it as carrying away over two-thirds of the energy which should be ours, and which would be by a complete combustion.

These losses in the furnace are due, therefore, to poor firing and incomplete combustion. To reduce them to the smallest possible limit the fireman must know his business, and be willing to properly attend to it. In addition, there must be provided, by proper design, the necessary supply of air both above and below the grate, together with such other arrangements as experience may show are needed for good combustion with the fuel in hand. Still, try as we may, there will be some loss, though with care and good design it may be reduced to perhaps not more than 2 or 3 per cent, or even less. With carelessness and poor design, however, it may reach a very serious amount, 10 to 20 per cent being no unusual figure for such conditions.

For illustration we will take this loss at 4 per cent, and represent it by the little rectangle *DEFG*. Then the remaining part, *CDGI*, will likewise represent the total amount of heat actually liberated. In the present case this amount is 96 per cent of the whole. This fraction is usually called the *efficiency of the furnace.* That is, if we consider it the office of the furnace to liberate all of the heat by complete combustion, then the fraction which is actually liberated is naturally called the furnace efficiency. In the present case this would be then 96 per cent.

We next consider that the furnace should pass this heat over to the boiler heating surface, whose office it is to transfer it through into the water on the other side. This is one of the series of changes to which the energy is to be subjected. It is still retained in the form of heat, but is to be given from the hot gas to the water which it transforms into steam. This change is

effected simply because water or steam is more convenient than hot gas for use in an engine for obtaining mechanical work. It is the office then of the heating surface to pass the heat from the hot gas formed by the combustion of the coal through into the water. This, however, cannot be completely accomplished, and here comes in the second loss. A part of the heat, instead of getting through the heating surface, goes up the funnel with the escaping gases, and so gets away into the outside air, and thus beyond all reach of use in the formation of steam. Another and much smaller part escapes by radiation out into the fire-room. These losses of heat it is impossible wholly to avoid. It would be necessary to prevent all loss of heat by radiation into the fire-room, and to reduce the temperature of the products of combustion in the funnel to that of the outside air. The latter especially cannot be done for a variety of reasons. In the first place their temperature cannot be reduced below that of the steam and water in the boiler, because heat always flows naturally from a hot body to a cooler one, and it will therefore flow from the gas to the water only so long as the latter is the cooler of the two. Actually the temperature of the escaping gases will be much higher than the steam, because in the first place sufficient heating surface to reduce them nearly to the same temperature could hardly be afforded; and again, aside from blowers, the strength of draft is dependent on the temperature of the hot gas in the funnel, and for a satisfactory rate of combustion it is necessary to discharge the products of combustion at a temperature of from 500 to 700 degrees. This loss is one, therefore, which exists in the very nature of things, and in the usual case cannot be reduced below from 20 to 25 per cent. No definite figures can be given for the loss by radiation into the fire-room, but it would be very small, and, in any ordinary case, quite inconsiderable in comparison with that which we have just discussed. In the present case, for illustration, we will take this second series of losses at 24 per cent. Reckoned on the original base, this will be 24 per cent of 96 per cent, or about 23 per cent of the whole. In the diagram let this be represented by *GHLM*. Then the amount of heat energy which traverses the heating surface and takes part in the formation of steam is 73 per cent of the whole, represented by *HIJL*. The fraction $GHLM \div GIJM$ gives the percentage of loss, and $HIJL \div GIJM$ gives the percentage transferred. This is usually called the efficiency of the heating surface, and would here equal 76 per cent. The total area $FHLC_1$ represents the total loss to this point, or 27 per cent of the whole, while the fraction $HIJL \div FIJC_1$, or 73 per cent, is called the efficiency of the boiler.

We come now to the third step in our series of operations. The steam, carrying with it the heat energy which it has received, is to be transported along a pipe and given over to the engine. A part of the heat escapes, however, by radiation from the boiler and steam pipe, resulting in the condensation of part of the steam back into water again. Here, then, is another loss whose amount will depend on the length of the pipe, and whether bare or covered with non-conducting material. By properly covering or lagging the boiler and pipe with non-conducting material this loss may be reduced to a very small amount, while with a long bare pipe it may become very considerable. In the present case we will take the amount at one per cent of the heat in the steam. Let this be represented by the rectangle *KLNO*. This, referred to the original amount as a base, will be 1 per cent of 73 per cent, or .73 per cent. The remainder represented by the rectangle *JKOQ* is the energy which finally reaches the steam chest and is handed over to the engine, amounting to 73—.73, or 72.27 per cent. Similarly the rectangle KC_1D_1O represents the sum of all the losses to this point, the amount of which will be 4 + 23 + .73, or 27.73 per cent.

We come now to the fourth step in our history, involving the most important of the various operations, and the most serious of all the losses. The energy which has so far been in the form of heat, is now to be transformed into mechanical work in the engine. In effecting this a most serious loss necessarily occurs. This comes about in two ways. First; when heat is transformed into mechanical work, even the most perfect engine possible is unable to effect the change without a large loss. Second; the actual steam engine falls far short of attaining to the possibilities of this ideally perfect engine. With such an engine the fraction of the heat which can be changed into work is expressed by the difference between the highest and lowest temperatures of the steam, or other working substance, for the numerator, and the highest temperature plus 460.7 for the denominator. Thus, for example, if the steam enters at a temperature of 350° and exhausts at a temperature of 130°, the fraction is 220 ÷ 810.7, or about 27 per cent. That is, only about one-quarter of the heat is transformed into work, nearly three-quarters being utterly lost in the operation. And this is the very best that could be done between these temperature limits by the most ideally perfect engine possible. Practically such an engine cannot be built, although the conditions which must be fulfilled are simply stated, and are as follows: The whole operation must consist of four parts. During the *first* the working substance should receive all the heat which is to be given it. During the *second* it should be allowed to expand, but without giving up or receiving any heat. During the *third* all the heat should be removed which is to be taken from the substance. During the *fourth* it should be compressed under such conditions that it shall neither give up nor receive any heat, and shall finally come back to its original condition of volume pressure and temperature. The operation is then repeated in successive similar rounds or cycles. As before stated, no such engine can be practically constructed, and no actual engine can fulfil these conditions, or reach the corresponding efficiency. In fact, the actual engine works on a cycle of operations quite different from those specified above. Into the details of these variations we cannot here enter, but in consequence of them the actual engine is only able to realize from 60 to 80 per cent of the efficiency of the ideally perfect engine as given in the foregoing. This gives then from 15 to 20 per cent as the engine efficiency for good practice with triple or quadruple expansion engines using from, say, 17 to 12 lbs of steam per I. H. P. per hour. This covers the range of what may be called good practice.

This loss, then, of from 80 to 85 per cent of all the heat coming to the engine is due partly to the very nature of the operation, and partly to our inability to realize the most favorable conditions. Increase of pressures, decrease of clearance, the use of jackets, reheaters, superheaters, etc., may all tend toward a reduction of this loss, but at the very best the amount of improvement which can be hoped for is but slight in comparison with the amount of the loss itself. In the present case for illustration, we will suppose that the loss at the engine is 83 per cent of the heat provided by the steam. This referred to the original amount as a base will be 83 per cent of 73.27 per cent, or 60 per cent. Let this be represented by the rectangle *OPTU*. The remainder represented by the rectangle *PQRT* is the amount transformed into mechanical work developed in the cylinders, amounting to 72.27 — 60 = 12.27 per cent. Similarly the rectangle PD_1E_1T represents the total loss to this point, the amount of which will be 4 + 23 + .73 + 60 = 87.73 per cent. The ratio of the rectangles *PQRT* ÷ *OQRU*, or 17 per cent, represents the efficiency of the engine, while the ratio *PQRT* ÷ QD_1E_1R, or 12.27 per cent, represents the efficiency of the whole operation of this point.

The amount of work thus developed in the cylinders we commonly call the I. H. P. or indicated horse power. This work has now to be passed along to the propeller, and here a further loss arises. Friction in the engine and shaft bearings is always present to absorb its share of the work, and only the remainder is finally delivered to the propeller. The action of friction in thus absorbing work is familiar to us all. This resistance is met with wherever there is a rubbing or turning joint—between the pistons and cylinders, in the stuffing boxes, cross-heads and crank-pins, valves and valve gear, crank, line and thrust-shaft bearings, and stern tube. At all of these points a resistance is encountered and a little of the work developed is lost. The reduction of this loss requires special attention to workmanship and lubrication, but at the best we cannot expect to reduce it below about 10 or 12 per cent, while under poorer conditions it may readily rise to 15 or 20 per cent. In the present case we will take the amount at 13 per cent of the I. H. P. This referred to the original amount as base will be 13 per cent of 12.27 per cent, or 1.60 per cent. Let this be represented by the rectangle *STVW*. The remainder *RSWY* represents the delivery to the propeller, amounting to 10.67 per cent. Similarly the rectangle SE_1F_1W represents the total loss to the point, amounting to 4 + 23 + .73 + 60 + 1.6 = 89.33 per cent. The ratio *RSWY* ÷ *RTVY*, or 87 per cent, represents the mechanical efficiency of the engine, while the ratio *RSWY* ÷ RE_1F_1Y, or 10.67, is, of course, the efficiency of the whole operation to this point.

We now come to the last operation and last loss in our series. The work delivered to the propeller is not all utilized by it in driving the ship ahead. The *useful work of propulsion*, that which would correspond to the work of towing the ship at the given speed, is usually from 65 to 70 per cent of the work delivered to the propeller. The remaining 30 to 35 per cent is spent on the water in giving it sternward motion and in churning it into eddies and whirls, and in doing work which results from the interaction between the ship and the propeller. This loss likewise is one which exists in the very nature of the operation, and we cannot hope practically to reduce it much below the smaller amount before mentioned. For the best results obtainable we require a propeller of proper form and specially designed to suit the given conditions, having in view all the special circumstances of the case. With a poorly designed propeller the loss may rise to 40 or 50 per cent or even more.

In the present instance we will take such loss at 32 per cent of the work supplied. This referred to the original amount as base will be 32 per cent of 10.67 per cent, or 3.41 per cent. Let this be represented by the rectangle WXA_1B_1. The remainder $XYZA_1$ represents the finally useful propulsive work, amounting to 7.26 per cent. Similarly the rectangle $XF_1G_1A_1$ represents the total loss, amounting to 4 + 23 + .73 + 60 + 1.6 +

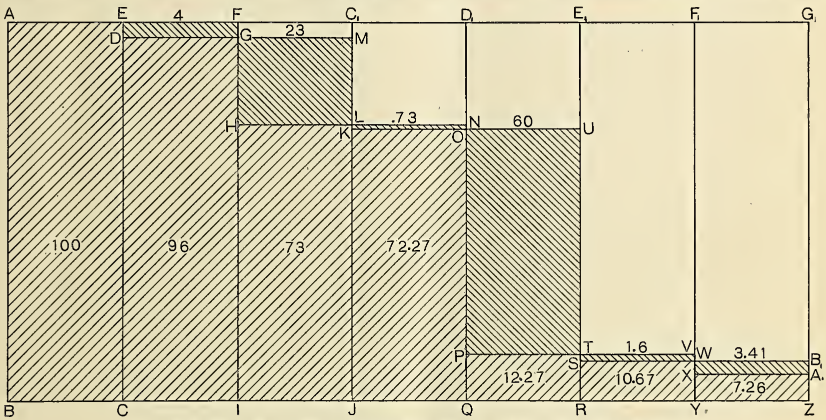


DIAGRAM SHOWING GRAPHICALLY ENERGY LOSSES FROM FURNACE TO PROPELLER.

3.41 = 92.74 per cent. The ratio $XYZA_1 \div WYZB_1$, or 68 per cent, might be considered as the propeller efficiency, though as here defined, it is rather an efficiency depending on both ship and propeller and their mutual interaction.

Referring now to the diagram in general, the successive rectangles hatched downward and to the left show the successive values of the useful energy as it progresses through the various stages on its way from the coal to the propeller. The numbers within the rectangles show the values resulting from the various losses selected for illustration in the present case. As already noted, such values are subject to considerable variation in different cases, but those given may be taken as showing fairly good practice with triple expansion engines and steam pressures from 150 to 180 lbs. The rectangles hatched downward and to the right represent the individual losses with amounts as indicated just above them, while the whole rectangle from the lower side, as PT to the top of the figure D_1E_1, represents at any stage the total loss up to that point in the process.

In the present case we have for simplicity followed through the operations for the main engine alone, and omitted reference to the auxiliaries. For the independent auxiliaries a part of the steam is directly used for their operation, and we should have a series of special histories for each, similar in nature to that for the main engine, but differing in detail according to the character of the auxiliary engine, and the work it is required to perform. For the attached auxiliaries, if there are such, a part of the power developed in the main engine is required for their operation, the remainder going on to the propeller as described in the foregoing. These variations involve, however, nothing different in principle, and for simplicity the detailed discussion and diagram were limited to the consideration of the main engine alone.

What then is the final result? 7.26 per cent saved out of 100 available at the start—about 1 part in 14, or 1,000 heat units per lb. of good coal out of the 14,000 which it has available. This seems like a disheartening result, but such should never be the attitude of the engineer. He must realize that these losses are the result of the laws of Nature, as we are at present able to interpret them. He is not to blame himself for inability to overcome a law of Nature, but rather only for neglect to make the most of the possibilities under these laws as they are understood. Let us, then, as engineers, realize our duties and privileges in this light, and within the limitations which surround us, work for the decrease of this constant chain of losses which invariably attend every operation with energy.

S. S. Alaska—The sale of the famous old Guion liner *Alaska*, known in her prime as the "Greyhound" of the Atlantic, has been reported sold for about $90,000 for breaking up. She was built less than twenty years ago at Govan on the Clyde in the yard of John Elder & Co., now the Fairfield Shipbuilding Co., and was a remarkable vessel. When the Guion line went out of business she was laid up in the Clyde and has not been in regular service since.

REMINISCENCES OF EARLY MARINE STEAM ENGINE CONSTRUCTION AND STEAM NAVIGATION IN U. S. FROM 1807 TO 1850.*

BY CHARLES H. HASWELL, M.E.

In some reminiscences of early marine engine construction and steam navigation in the United States, presented recently to the Institution of Naval Architects of Great Britain, the writer stated that down to 1822 the engines were of the vertical crosshead type, connected with sliding clutches directly to the water-wheel shafts, and also geared to a shaft with a fly wheel at each end of it. The object of the connection was to enable the water wheels to be disconnected and the engine operated independently to feed the boiler and operate the bilge pump when the vessel was at a pier or anchored, as independent steam, feed, bilge and fire pumps were then unknown. The steam and exhaust valves, if puppet, were operated by the hand gear of Beighton; when otherwise, the long slide valve was used.

This type of engine, with the crosshead, connecting-rods, cranks and shafts of cast iron, the key, crank and pin holes cored and cast in, was wholly used until about 1822, when the vertical overhead beam was introduced, and when the horizontal or inclined engine was introduced the short slide valve was resorted to, except in the southern and western waters, where the lever puppet, operated by a cam, was wholly employed.

The boilers, with the exception of the very first few, which were plain cylindrical, set in masonry, were of copper plates of the design termed "D. and Kidney Flue," having but one furnace, the full width of the inner space of the front, the flame and gases of combustion leading through a flue of about two-thirds the width of the furnace into a back connection, and thence into a return flue, which, from the outlines of its transverse section, was termed a "kidney flue." From this they were led to a short vertical flue at the back of the furnace, and then extending up to the shell of the boiler, in a short shoulder of which the base of the smoke pipe was set. The cause of this convexity to the inner side of the main flue, and the indentation given to the inner side of the other, was because the curved surfaces rendered the socket bolts of plain surfaces unnecessary, with the limited steam pressure of 15 lb. or less per square inch.

In southern and western waters, where non-condensing engines were resorted to because the waters of the rivers were too turbid for the continuous operation of a condenser, wrought iron cylindrical boilers alone were used and the character of the iron was such that the plates were cold riveted. They were generally internally fired, in some cases externally, and it was not until about 1820 that marine boilers were constructed of iron in eastern waters.

BOILER PLATES.

Boiler plates were punched manually by the aid of a long wooden lever, on which four men exerted their power, and as the location for the punch was directed only by the eye of the operator, the spaces were frequently irregular, involving pinning, in order to bring

*A paper read before the Institution of Naval Architects in London.

the holes as nearly opposite as practicable, and, hence, the plates were frequently strained and the rivets set at an inclination. All of the latter were hand made, but in the East they were driven hot.

BLOW OFFS.

Blow offs were not attached to boilers until steam navigation was well advanced. The exact period is not now ascertainable—probably about 1822. The boilers of steamboats on the bay and river routes, with the low pressure, and the consequent low temperature, of steam with which they were operated, did not involve the necessity of the frequent blowing off of saturated water from their boilers, and the water was allowed to run out of them at the end of each passage. They were then refilled with fresh water. In consequence of this neglect of blowing off, and the imperfect manner in which the plates were riveted, a boiler at the end of a trip in wholly, or even partially, salt water would be loaded in its seams and joints with incrustations and stalactites of salt to an extent that involved their being hammered and scraped off. Felting of a boiler was unknown.

FINISHING.

So deficient were the facilities of lathes, planers, slotters and drills that "black work" of engines, as it was termed, was the prevailing finish. The connecing-rod of a large vertical beam engine in the *Victory* was wholly finished in the smith's shop, its body, after forging, being dressed by swaging, the key holes drifted, and the ends and straps dressed with a flatter on an anvil, and a horse file.

CYLINDER PISTON PACKING.

Cylinder piston packing consisted of hemp gaskets, and if the safety valve of the boiler was not raised during the initial raising of steam, the steam around the chimney flue would become so dry as to char the wood blocking between the ribs of the piston, and also the piston packing; hence lead pipes, through which the gaskets were drawn, were resorted to.

ACCESSORIES.

Counters, indicators, salinometers, brine pumps, steam and vacuum gauges, metallic packing, whistles, and oil cups other than the one in the cylinder head, by which the piston was lubricated on its exhaust side, were unknown.

COMPOUND OR WOLF ENGINE.

About 1824 James P. Allaire, of New York, constructed the steamboat *Henry Eckford,* with a vertical crosshead compound engine, the center shafts geared to the wheel shafts; but, in the absence of a receiver, the mutual operations of the cylinders were only at the extreme of the opposite strokes of their pistons. Soon after, and up to 1828, he constructed five other boats, namely, the *Sun, Commerce, Swiftsure* and *Pilot Boy,* with like engines, and the *Post Boy* with an overhead beam engine, the cylinders being set at its opposite ends; but as this type of compound engine operated at the moderate pressure of 25 lb. per square inch, it did not attain such an effect as to justify the increased cost and weight of two cylinders and their connection, and its further construction was abandoned.

STEAM CHIMNEY.

In 1827 Mr. Allaire invented the steam chimney. The original design was that of two cylinders of boiler plate, one within the other, connected and closed at both ends, the inter-space being about 5 in. in width, with a vertical diaphragm, connected near its upper end to the outer shell above, where steam was admitted from the boiler through two or more connecting pipes. These served also as fastenings and to hold the chimney in position. This diaphragm led down to within a few inches of the bottom of the chimney, and the steam was inducted down and under it, then up and around the inner cylinder, and thence to the steam pipe opening in the top; thus the steam deposited its contained water in the chimney, to be vaporized by the heat at the base, and received also heat from that ascending the chimney; hence a material economy of fuel was attained with the advantage of obtaining dry steam. Boilers at this period did not foam (prime); the great proportionate volume of water, its area at the water line, and the moderate heat in the furnace, from wood, with but a natural draft, precluded it.

BREAKDOWN.

In 1828 the engine of a large steamboat, the *Chief Justice Marshall,* on the route from New York to Albany, broke down by the breaking of the head of her piston rod at its insertion into the crosshead socket; the crosshead, both connecting-rods, and a center crank were broken, and in four days new castings from the builder's patterns were made, the piston rod was repaired, all fitted, and the engine was ready for operation.[1]

In this connection it is to be considered that neither the eye of the crank was reamed nor the key holes of the rods slotted; the crank eye and the ends of the rods were submitted only to the operation of a coarse file.

ATTACHMENTS TO ENGINES.

In the attachments to engines and boilers the steam gauges were constructed in the smith's shop, and consisted of an iron tube half an inch in diameter and 4 ft. in length, bent, with one of its legs 15 in. in the clear in length, and in the other the balance of its length was filled with mercury, on which was placed a light pine rod, the rise and fall of which, shown on a tin plate divided and numbered in inches, designated the pressure of the steam in pounds per square inch.

EARLY STEAM NAVIGATION.

Steam navigation, up to the latter part of 1839, was confined to Long Island sound, the southern and western rivers, and Canadian lakes and rivers, with a single passage of a steamboat from New York to Philadelphia, the *Phœnix,* in 1807, and one on the route from Havana to Matanzas, and one from Charleston to Savannah. In 1819 the auxiliary steamer *Savannah,* of 380 tons, steamed and sailed from Savannah to Liverpool, she being the first steamer to cross the Atlantic ocean.

In 1825 Mowatt Brothers, of New York, owners of the steamboat *Henry Eckford,* attached a loaded barge to her, and transported it from New York to Albany; this was the first essay of steam towing, and, although its insufficiency and impracticability were generally predicted, the enterprise proved to be a great and lasting success.

In 1826 a fan blower was first introduced under the

[1] Witnessed by the writer.

grates of the boilers in the steamboat *North America*, of the Messrs. John C. & Robert L. Stevens.

In 1828-1829 the rivalry for speed between the steamboats plying on the route from New York to Albany was so great that, in the design of the boats, their beam was disproportionate to the weight of the engine, boilers and deckhouses above, and they proved unstable. In order to reduce this condition large logs of light pine wood with sharp ends were firmly suspended under the after wheel guards and depressed for half their diameter below the water line, and in operation they measurably improved the stability of the boat.

In 1830 the patent of the steam chimney of Mr. Allaire was invaded, and its operation simplified by making the double cylinder an integral part of the boiler, open at its lower end, and extending to such a height above the boiler as to give the necessary surface to superheat the steam. The height and volume of steam space helped measurably to arrest foaming, by admitting the subsidence of the water physically borne with the steam in its flow to the steam pipe.

Gongs for the engine-room were unknown, and in many of the boats, when the pilot was in his house (if there was one) or on the deck over the engine-room, he would signal to the engineer by the strokes of a stick or cane upon the floor of the house or deck.

All boats, of course, carried bells, and by them all notices of departure and of arriving were made known, and all salutes between boats were given by their bells. To blow steam, as is now done by a whistle, was intended to be a challenge or an insult.

In July, 1837, the first steam launch, the *Sweetheart*, 35 ft. long, 4 ft. 3 in. beam, and 3 ft. depth, engine 4 by 12 in., wheels 3 ft. 6 in. dia., and boiler horizontal fire-tubular, designed and constructed at the United States Navy Yard, New York, by the writer, then chief engineer of the Navy, was completed, and on her trial and succeeding trips around the city of New York was saluted with the bells of passing steamboats and cheered by people who rushed to the ends of the piers to witness the novel sight. She attained a speed of 8.5 miles per hour. The engine was subsequently transferred to the United States Naval School at Annapolis.

Fuel, up to the year 1836, was wholly pine wood, though up to that time some owners of steamboats commenced experimenting upon the practicability of using anthracite coal. A steamboat on her route of six or more hours could not have the capacity in her fire-room to contain all the wood required, and was compelled to pile it upon her side houses; and such boats as were on a long route, as from New York to Providence, were compelled to invade their upper deck with wood, and upon leaving the city had somewhat the semblance of a floating woodyard.

In 1836 James P. Allaire commenced the running of a steamboat, the *David Brown*, a light-built river boat with deck-houses and promenade deck, from New York to Charleston, S. C., and return, the enterprise being almost universally held to be utterly impracticable. It was successful, however, and soon afterward he built two other and larger boats for the same route, and from that period coastwise steam navigation was held to be so practicable that various lines to other ports were established. The *David Brown* was fitted for this new service with planking under her water-wheel guards, closely joined and caulked, extending from the inside of the string piece to the light water line, which shielded the guards from being forced up by a sea. This device, after several essays at a proper term, is now known as the sponson.[2] In some cases on coast routes, instead of a closed shield open slatting was resorted to.

In the year 1837 the first propeller steamer was introduced. In 1838 Phineas Bennett designed, patented and introduced in the steamboat *Novelty*, plying on the Hudson river, a vertical cylindrical boiler in which a hermetically closed furnace was supplied with air by a pump, and all the gaseous products of combustion of the fuel were driven into the steam room of the boiler; the object of this design was to increase the generation of steam and reduce the proportionate area of heating surface.[3] The boiler was removed after a short period of service.

Soon afterward Phineas Bennett introduced the design into a vessel built to ply between New York and Liverpool, under the conditions with her builder that if the design proved to be acceptably successful he was to be paid for the entire plant of engines and boilers and his services, but if not successful he was to remove the entire plant, and at his own expense, without any remuneration whatever. The engines and boilers were completed and operated, but they were not paid for by the builder of the vessel, and the boilers were soon after removed and replaced with others. In consequence of the ashes borne into the valve chests and cylinders, and the evaporation of the oil of lubrication by the heat of the steam, the valves were rapidly worn, and the cylinder pistons shrieked to a degree that would have rendered the design very objectionable, even if it had been successful in other points.

Captain John Ericsson arrived in New York in this year, and in 1842 he designed and directed the construction of the engines and propellor for the United States auxiliary bark-rigged steamer *Princeton*.

In the year 1839 anthracite coal was introduced in the furnaces of the steamboat *North America*, plying on the Hudson river between New York and Albany, and to aid its combustion when a high pressure of steam was required a fan blower, driven by a belt from the wheel shaft, was first resorted to, but soon afterward a small independent engine was used, connected by a belt to the blower.

Anthracite coal was soon afterward first burned without auxiliary draft in the open furnace of a steam boiler.

In the year 1840 wrought-iron shafts were first made, the construction varying wholly from that of the present period; thus, iron bars from 2.5 in. to 3 in. square and of the greatest obtainable length were laid up with a square section, the abutting ends breaking joints with the other bars; hence, the solidity of a section of the mass was subjected only to any imperfection arising from their ends not being wholly welded, by the percentage of the section of one bar to the whole number; and of all the shafts made up to the period included in this paper, only one was broken, and that in conse-

[2] This term was given also by the writer.
[3] Witnessed by the writer.

quence of its being insufficient in diameter for the stress to which it was subjected. This result was foretold when the diameter of the shaft was reduced from that given in the specifications.

The first steam frigates for the United States were constructed in 1842.

Captain John Ericsson applied a surface condenser to the engine of a revenue cutter in the year 1846, and in 1848 Pierson designed an improvement of it, which was further improved by Chief Engineer William Sewell of the United States Navy, and the perfected instrument is now in general, if not in universal, use.

The *Atlantic* and *Pacific*, of the New York and Liverpool SS. Company, "Collins Line," were constructed in the year 1848, and in July, 1850, the *Atlantic* made the then quickest passage between New York and Liverpool, it having taken but ten days and fifteen hours. The *Arctic* and *Baltic* of the same line were launched in the same year.

HORSE POWER—1850.

It was wholly impracticable to obtain the consumption of fuel per indicated horse power in early steam engineering, as engines were not fitted with counters or indicators, and the wood was not weighed. In 1840, with auxiliary or blower draft, and in the absence of counters and indicators, it was computed by weighing the coal consumed, and held to be about 5 lbs., and the speed of the river boats from 8 1-2 statute miles in 1816 increased to 19 miles.

The Clyde line steamship *Pawnee*, Captain A. D. Ingham, took fire at sea and was abandoned off Currituck, North Carolina, at an early hour in the morning of June 26. The vessel was bound from Brunswick, Ga., to Boston, and carried a cargo chiefly of lumber. The steamer *George W. Clyde* of the same line came up and took off the crew and Captain of the burning vessel. The *Pawnee* was a wooden, single screw vessel, measuring: Length, 203 ft.; beam, 38 ft., and tonnage, 1,300 tons. She was built in 1890 at Philadelphia, Pa.

In a recent issue *The New York Maritime Register* announces the thirtieth anniversary of its birth, and we take this opportunity to express a wish that it may enjoy "many happy returns." The value of such a publication to the maritime and merchant interests of the country is enormous, and the task of compilation equally great. But the management is progressive, and, not satisfied with taking the foremost position as an American Shipping Index, announces that the intention is to place the paper at the head of its class throughout the world. To this end an addition has been made to the store of information contained in each issue, so that a list of vessels is given, "no matter in what trade or in what part of the globe they may be engaged, that are available for chartering, or for the reshipment of goods, thus ignoring of the world's fleet only foreign coastwise craft." This adds to the previous regular lists not less than two thousand vessels additional. The paper is sold by subscription, and among those who find it indispensable are Merchants, Exporters, Manufacturers, Banks, Editors, Diplomats and Statesmen. The office of publication is 63 William street, New York.

AMERICAN SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

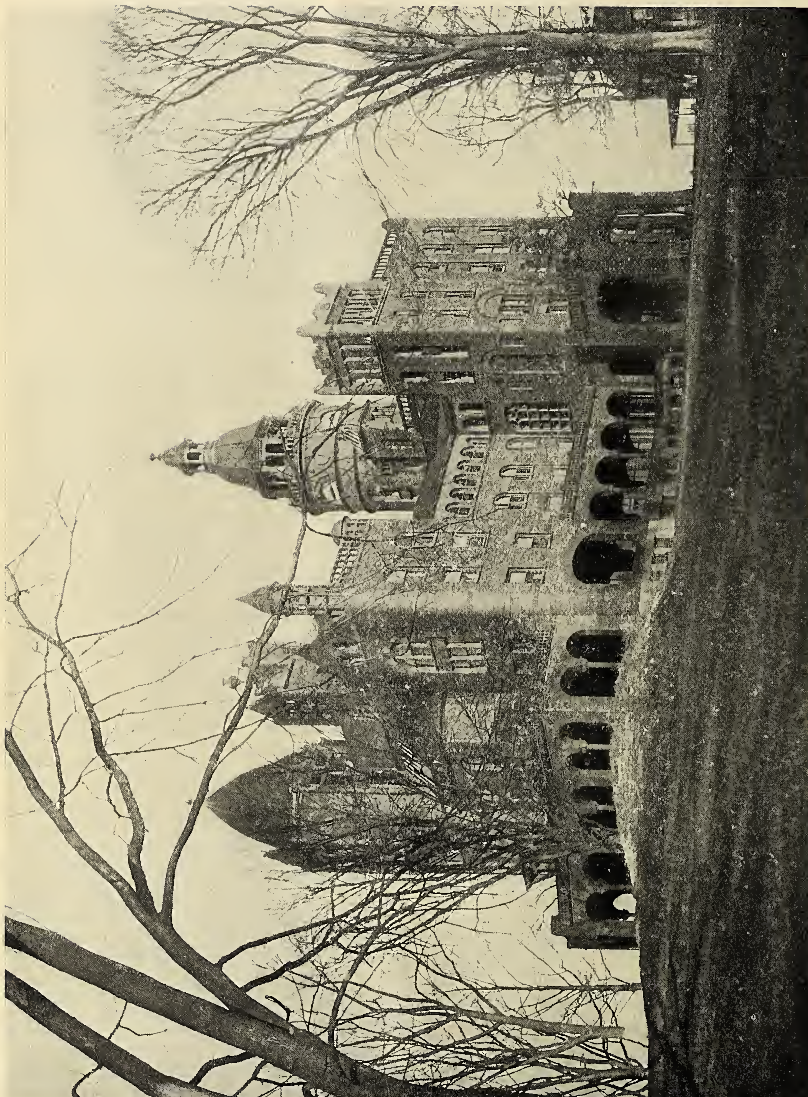
WEBB'S ACADEMY OF NAVAL ARCHITECTURE AND MARINE ENGINEERING, FORDHAM HEIGHTS, N. Y.

Founded by William H. Webb, Shipbuilder, for the Free and Gratuitous Education of Students—Provision also made for the Board, Lodging and Necessary Expenses of Students while in Attendance.

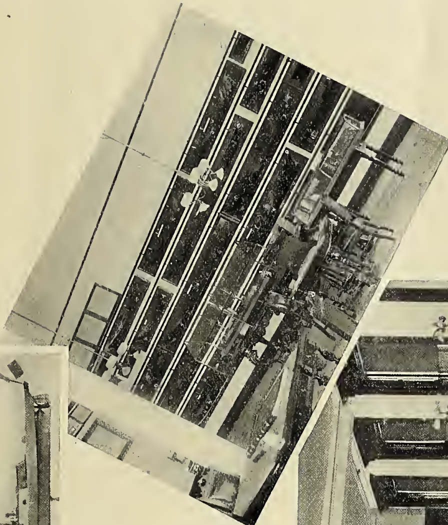
Situated at an elevation of about one hundred and fifty feet above the Harlem river, Webb's Academy of Naval Architecture and Marine Engineering is a conspicuous object in that section of upper New York. The architecturally handsome building is, indeed, a monument to the industry and philanthropy of its founder, William H. Webb, now advanced in years, but in his prime the foremost shipbuilder in the country. The history of this institution is part of the life history of its founder, so that a brief sketch of his career is necessary to clearly convey the purpose of the foundation.

William H. Webb was born in New York, June 19, 1816, his parents having moved from Southern Connecticut, where for many generations the family had resided. In early childhood William H. Webb manifested a liking for ships and ship construction, for instead of joining his playmates in youthful games, he passed his play-hours in boat-building and sailing. He received a good English education, which was completed at Columbia Grammar School, and in his studies he was especially proficient in mathematics. When he came to a choice of a career his father sought to dissuade him from learning the art of shipbuilding, on account of the boy's health, for he was then apparently not robust. No argument, however, could induce the son to take up any other profession, and he was apprenticed in his father's shipyard at the age of fifteen. From that time until the day of his retirement from active business life he was a diligent student and a faithful, energetic worker in the cause of the science and art of shipbuilding. The death of his father promoted him to a share in the business of the firm, and subsequently to the entire ownership.

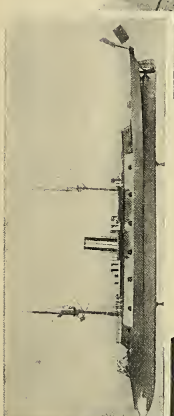
The younger generation in American shipping circles is not personally familiar with Mr. Webb's work, but older men will recollect the series of triumphs that his skill as a naval architect won, not only for his yard, but for the country. Every class of vessel was turned out, and in warships especially the output was equal, and in many respects superior, to anything afloat. Ships were built not only for this side of the Atlantic, but for European nations. For example, the *Re d'Italia*, built for the Italian government, was the first iron-clad to cross the Atlantic, and was famous for her remarkable seagoing qualities and, then, extraordinary speed. The *Dunderberg*, built under contract for the United States, but eventually sold to France and re-christened *Rochambeau*, is considered the most remarkable production of the Webb yard. Though built thirty-five years ago, she embodied many



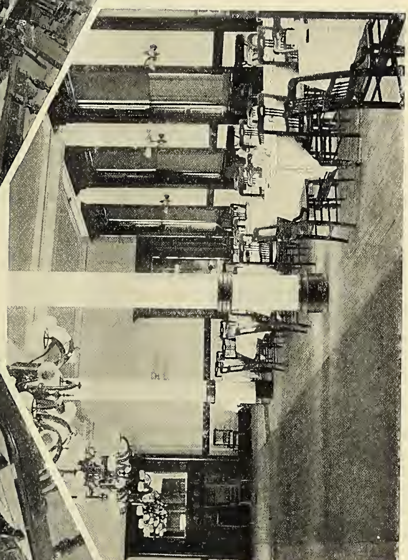
WEBB'S ACADEMY OF NAVAL ARCHITECTURE AND MARINE ENGINEERING, FORDHAM HEIGHTS, NEW YORK CITY.



Ship's Models in the Museum



Model of Warship Dunderberg.



In the Students' Dining Room.

A Corner in the Museum.

INTERIOR VIEWS IN WEBB'S ACADEMY, FORDHAM HEIGHTS, N. Y.

ideas which have been put forward as new in modern days. Her model, shown in the illustration on page 11, gives an idea of the advanced style of construction, when compared with conventional warship practice of the period. Her dimensions were: Length 378 ft., beam 68 ft., depth of hold 22 ft., and displacement 7,000 tons. When armed and ready to fight she had a sea speed of 15 3-10 knots, which at the time created a sensation, and which, indeed, is about equal to the sea speed of our modern battleships in commission.

Concurrently with his professional work Mr. Webb took a real interest in many public affairs, and gave much attention to the educational problem. Recollecting the difficulties he had encountered in acquiring a knowledge of the science of his profession, he determined to found an institution where Naval Architecture and Marine Engineering would be taught to deserving students without any cost to them. About ten years ago his ideas found practical expression in the incorporation of Webb's Academy and Home for Shipbuilders, which was accomplished on April 2, 1889. This was with the approval of the then Governor, David B. Hill, and the limit of value of the property to be held by the corporation was fixed at ten million dollars.

The site finally selected by Mr. Webb for the founding of the Academy and Home is located at Fordham Heights, New York City, on the easterly bank of the Harlem river, just north of the University of New York, and contains about fourteen acres, upon which are numerous large shade trees and extensive lawns. Situated at an elevation of one hundred and fifty feet above the level of the Harlem, the grounds command an excellent view of the picturesque surrounding country.

Work upon the construction of the building was begun in 1890, and was completed in February, 1894. It is built of yellow pressed brick, with brown-stone trimmings. The greater part of the structure is five stories in height, with two additional stories on that portion occupied by the Academy. Around the southern end and part of the east and west sides of the building there extends a very wide veranda, while each end of the building is marked by a very high tower. Half hidden as it is by the surrounding grove of trees, its architectural beauty is not realized until one has entered the grounds. The cost of the building and its furnishings, together with the grounds, reached nearly half a million dollars. The proper maintenance of the institution has been amply provided for by Mr. Webb by the deeding to the corporation of very valuable property situated both in New York city and elsewhere.

The dedicatory exercises were held in May, 1894, at which time the property was formally presented to the Trustees. At present the Board of Trustees is composed of William H. Webb, president; Stevenson Taylor, vice-president and general manager; Stephen M. Wright, secretary and treasurer; Andrew Reed, resident manager; together with Thomas F. Rowland, Charles H. Cramp, Henry Steer, George Rowland, William H. Fletcher, Thomas S. Marvel, James O. Poillon, Herbert Lawrence, and Lewis Nixon, and Alexander E. Orr, representing the Chamber of Commerce; Warren A. Conover, the General Society of Mechanics and Tradesmen; Prof. Frederick R. Hutton, Columbia College; and Sheppard Gandy, the New York Hospital.

As its name would indicate, the institution provides a home for aged, indigent or infirm men who have been engaged in building hulls of vessels or marine engines for such, together with the wives or widows of such persons; and an Academy to "furnish to any young man, a native or citizen of the United States, who may upon examination prove himself competent, of good character and worthy, free and gratuitous education in the art, science and profession of shipbuilding and marine engine-building, both theoretical and practical, together with board, lodging, and necessary implements and materials while obtaining such education."

The ground floor of the building contains a spacious hall and broad stairway, reception-room, parlor, a suite of rooms each for the matron and housekeeper, an office for the resident manager, and an extensive dining-room. The floor above is devoted wholly to sleeping-rooms, with the exception of a reading-room and library, which has about fifteen hundred volumes, including both scientific works and fiction. On the third floor are more sleeping-rooms and the well-filled museum. It is here the visitor finds much of interest in the models of different craft built by Mr. Webb, varying from the little harbor tug to the powerful ram *Dunderberg*. Here the student of naval architecture notes the changes that have gradually taken place in the general construction of vessels during the last sixty years. Attention is also drawn to the large number of paintings and engravings illustrative of vessels, varying in type from the ancient galley to the modern warship. Sleeping-rooms occupy the whole of the fourth floor. Then come two of the drawing-rooms, the instructor's office, the mould loft and the workshop. The sixth floor has another large drawing-room and a lecture-room, while on the floors above the latter are the physical laboratory and gymnasium. There is a dark room for the development of photographs, and upon the roof a special arrangement for taking blue prints of the largest size.

The first examination of applicants for admission was held in January, 1894, at which time eight students were admitted, and in May following two more. Since then examinations for entrance have been held but once a year.

Candidates for admission must be between fifteen and twenty years of age, and their application must be made to the President of the Academy not later than the first day of September of the year in which the applicant expects to enter. Owing to the limited accommodations for students and the ever-increasing number of those applying, it has been found necessary to subject all candidates to a very rigid competitive examination in the subjects required for admission, which at present embrace the common English branches, together with algebra up to and including quadratic equations, geometry, both plane and solid, and plane and analytical trigonometry. These examinations are held annually on the Wednesday, Thursday and Friday next preceding the third Monday in September.

Of the students thus far received into the Academy, a large majority have come either from the vicinity of New York or from those States bordering upon the Great Lakes. During the history of the school the

following States have been represented by students: Maine, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Georgia, Ohio, Indiana, Iowa, Michigan and Minnesota.

The academic year begins in the second week in September and extends until the second week in June, with a short vacation at the Christmas holidays and at Easter.

Examinations are held at frequent intervals throughout the year, and students who fail to maintain the required standard of scholarship are summarily dismissed.

During the academic year all students must live in the Academy, but the privilege of spending Sundays at home is generally granted to those whose homes are in the city or nearby towns, providing their work has been satisfactory.

Promptness and regularity at meals are strictly insisted upon. The good health of the students is in no small degree due to this fact. In sickness they receive the care of one or more of eight physicians who render gratuitous service to the institution. In case of severe illness they may be removed to the hospital with which the Academy is provided. But one death has occurred among the students, and that was due to quick consumption.

Students have until ten o'clock at night to prepare for the succeeding day's work, and at that hour all lights must be extinguished. The work of the day is divided, according to the old-fashioned way, into two sessions from 9 to 12 o'clock in the morning, and from 1 to 4 o'clock in the afternoon. No sessions are held on Saturdays, but most of the students during the morning avail themselves of the opportunity of doing original or advanced work.

The faculty is composed of Prof. J. Irvin Chaffee, A.M., in the department of Mathematics, who has had an experience of seventeen years in educational work; Prof. Alexander J. Maclean in the department of Naval Architecture, who has been connected for twenty-two years with shipyards in England and the United States; and in the department of Marine Engineering Prof. Wm. Ledyard Cathcart, with an experience of eighteen years as an educator in the United States navy.

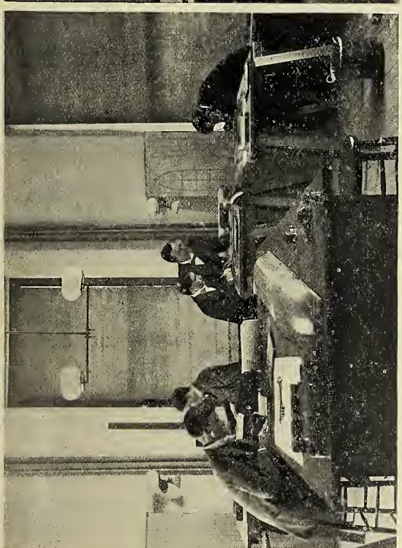
The course of studies extends over a period of three years, and is as follows: In Mathematics a course in Advanced Algebra is given in which are especially considered variables and limits series, continued fractions, the binominal theorem, determinants, theory of equations, and the general solution of equations; a supplemental course in Trigonometry covering the solution of trigonometrical equations; Descriptive Geometry with reference to the intersection of planes, curved and warped surfaces; Analytic Geometry covering (a) plane geometry as applied to loci and their equations, the straight line, the circle, different systems of co-ordinates, the parabola, the ellipse, the hyperbola, loci of the second order and higher plane curves, (b) solid geometry involving the point, the plane, the straight line and surfaces of revolution; the Calculus as a means for finding the quadrature of surfaces, the cubature of volumes, the center of gravity and the moment of inertia of different areas and volumes; in Hydrostatics pressures on surfaces are found, centers of pressure, resultant horizontal and vertical pressures, equilibrium of a floating body, stability and metacenter with special problems upon the same; Mechanics with special reference to rectilinear and periodic motion, curvilinear and rotary motion and projectiles; Strength of Materials with an exhaustive treatment of cantilever and simple beams, compression of columns, torsion of shafts, apparent stresses and true stresses and stresses in guns.

The course in Marine Engineering begins with a general investigation of modern marine engines, boilers and auxiliary machinery; of the conditions under which they work in practice; and of the subjects of fuels, combustion and evaporative efficiency. The indicator and its diagrams are studied, and, when opportunity is afforded, students make short passages on coast-wise steamers for indicator practice and the observation of marine machinery under weigh. A considerable amount of time is given during the first year to Mechanical Drawing and Tracing, the models for the latter being selected from the large collection of prints of marine engines which forms a part of the equipment of this department. The instruction in drawing is continued, through the reproduction in finished drawings of sketches with dimensions, to the preparations of original designs of engine details. The Valve-Gears used in marine practice are investigated and laid down. The subject of Heat is studied, and that of the Theory of the Steam Engine follows. The design, construction and operation of Marine Steam Boilers, and the design and drawing of various types of the Screw Propeller, are subjects on which stress is laid. The design of, and working drawings for, propelling machinery for vessels is begun in the second year and is pursued until the end of the course, including all important parts from the cylinder to the propeller. Students who make a specialty of Marine Engineering pass the vacation period in the machine shops of ship-yards or in the engine-rooms of sea-going vessels.

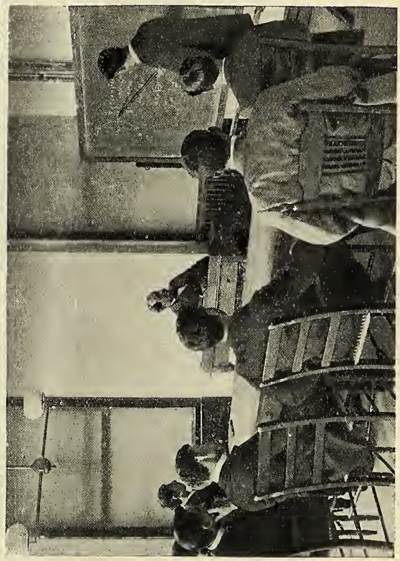
In Naval Architecture the course embraces both the theoretical and practical. The student is first required to make the calculations of areas and volumes to different water lines for a given vessel, then to get out a Displacement Sheet and the Tons per Inch Curve, the Area of Midship Section, together with its co-efficients, is found; the Center of Buoyancy, its position vertically for change of draught, and the longitudinal position of Center of Buoyancy are discussed and their loci found; Trim, Centers of Effort and Pressures, Tonnage, Freeboard and Surplus Buoyancy are treated; a vessel's Stability is considered, while calculations for and construction of curves of the same are made; Curves of Buoyancy, loads, sheering force and Bending Moments of different classes of vessels floating in still water are gotten out; the formula $\frac{p}{y} = \frac{M}{I}$ as applied to the ship as a girder is investigated; the Stability of different types of vessels under peculiar conditions. Resistance at surface and deeply submerged are inquired into; Stress on upper edge of sheer strake when vessel is inclined, and Stresses on the structure of the hull for different conditions of lading are investigated, followed by calculations especially required for Launching Diagrams.

The work in practical Naval Architecture is laid out along lines parallel to the theoretical, and consists of work in the drawing-room, mould loft and shipyards.

STUDENTS OF WEBB'S ACADEMY AT WORK IN THE MOULD LOFT AND IN THE WOOD WORKING SHOP.



Naval Architecture Draughting Room.



Recitation Room of Class in Mathematics.

Marine Engineering Draughting Room.

CLASS ROOMS IN WEBB'S ACADEMY, FORDHAM HEIGHTS, N. Y.

In the drawing-rooms the students familiarize themselves with the proper use of drawing instruments, planimeter, etc., make tracings of detail drawings, derive and plot the several curves mentioned under theoretical Naval Architecture; compare the scantlings of a given steel steamer with the different insurance societies' rules, prepare a sheer draught, and make a half model of the same. The different methods of preparation and assembly of the various parts of a ship in proper order, preparing slip, laying blocks, different ways of bending and setting frames, floors and beams, the laying and fitting of various kinds of keels, stern and rudder frames, construction of bulkheads, pillaring, hatches, bridges, etc., etc., are in turn considered and drawings of the same are made.

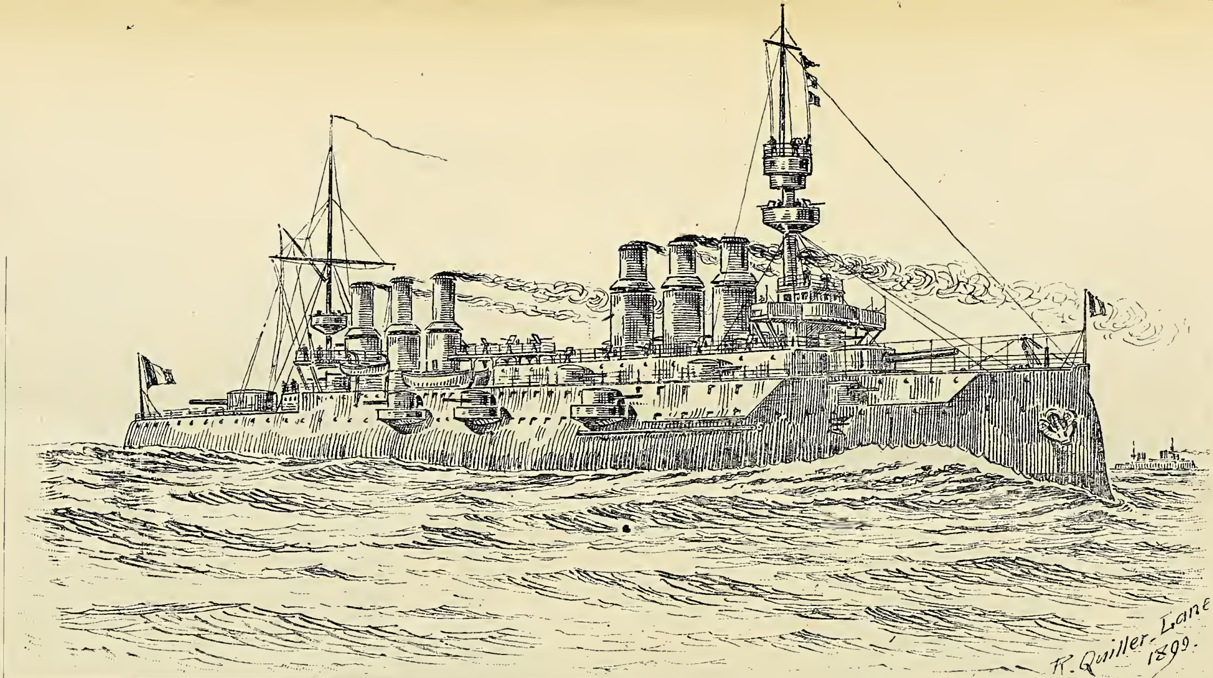
In the mould loft a wooden ship is first laid down and faired up, and moulds of the several parts actually made. This work is followed by the laying down of a cargo steamer, the working drawings of which have already been made in the drawing-room, and the preparation of the scrive board and moulds. A half model of this steamer is then made and lined off completely. Owing to the ample floor space of the mould loft much of the work can be laid out in full size.

Outside of their regular required work, students not infrequently devote their time to the making of beautifully-finished models, with which they decorate the walls of their rooms. Some even go so far as to actually build the craft corresponding to the model and design which they have made. A boat of the "skimming-dish" type was recently constructed by one of the students for use in shallow waters. The yacht *Corsair*, designed and built by members of the classes of '97 and '98, gives an idea of the ability of the students for such work. The *Corsair* was sufficiently large to furnish sleeping accommodations for six persons. After completion she was launched into the Harlem river, and thence passed through the ship canal into the Hudson river. Via this river, the Erie Canal and the Great Lakes the six students made the voyage to their homes at the close of the school year, and so successful and enjoyable did the trip prove that they returned by the same route in the autumn to resume their studies at the Academy.

In order that students may acquire a more extended knowledge of practical Naval Architecture and Marine Engineering than it is possible for them to secure at the Academy, all undergraduates must pass about eight weeks of the summer vacation at work in various shipyards throughout the country. While thus engaged they receive wages commensurate with the services rendered, and in many instances they are offered permanent employment; but they always return to complete their course at the Academy. Those students of the graduating class who wish to enter the employment of the Government are allowed to take the Civil Service examinations, which are held usually a month or two prior to the final examinations at the Academy. Every student who has taken these examinations has passed them successfully and received his appointment shortly after, and in some cases even before graduation. With the exception of one, whose eyes failed him, every graduate from this institution is either in the employ of the Government or engaged at some private shipyard. One is located on the Pacific, and all the others on the Atlantic coast.

The fact that the demand for graduates from Webb's Academy is far in excess of the supply shows the reputation which the institution has already acquired, and vindicates the judgment of the founder.

STUDENTS OF THE MANLY ART—A FRIENDLY BOUT AT WEBB'S ACADEMY.

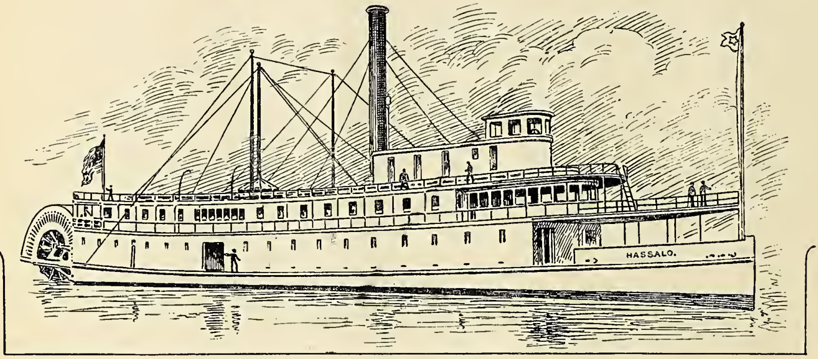


FRENCH TRIPLE-SCREW COMMERCE DESTROYER JEANNE D'ARC BUILDING AT TOULON—TO STEAM AT THE RATE OF 23 KNOTS.

So many vessels of the French Navy are in appearance what may be termed "freaks" that, to those familiar with the practice of that nation, the illustration of the new cruiser *Jeanne D'Arc* will seem "perfectly natural." The ship, launched at Toulon last month, is designed to be a veritable terror of the seas, to be turned loose on the commerce of any hostile nation in time of war. Her dimensions are: Length, 475 ft. 8 in.; beam, 63 ft.; draught, 26 ft. 8 in., and displacement, 11,270 tons. She is a triple screw vessel, with triple expansion engines of 28,500 horse power, with forced draft, and she will have a radius of action of 13,500 miles at ten knots and 1,200 miles at twenty-three knots. Her coal capacity will be between 1,400 and 2,100 tons, as occasion requires, and this will be supplemented by large tank space for liquid fuel. For producing steam forty-eight Du Temple water-tube boilers have been figured on, though some other type may be used. The *Jeanne D'Arc* is rather heavily armored, having a continuous belt at the water line 5.9 in. thick, and above this 3 in. armor plate, and she has also a 2 in. protective deck. Her powers of offense are provided for by two 7.6 in. breech loaders and fourteen 5.5 in. rapid firers and sixteen 3-pounders and eight 1-pounders. The construction of this vessel has caused a certain amount of uneasiness in British naval circles, though why this should be so, in view of the large number of tremendously powerful ships of the type possessed by the British, is not apparent. The steam trials of this new ship, when she is completed, will be watched with widespread interest for political as well as engineering reasons.

RECORD-BREAKING STERN-WHEEL STEAMER HASSALO FOR COLUMBIA RIVER.

The speed record for a stern-wheel steamer is claimed for the new river steamer *Hassalo* built at Portland, Ore., for the Oregon Railroad & Navigation Co. This is a remarkable vessel in many respects, combining as she does the conventional type of stern-wheel river steamer with the most modern methods in her equipment and in construction in her machinery department.



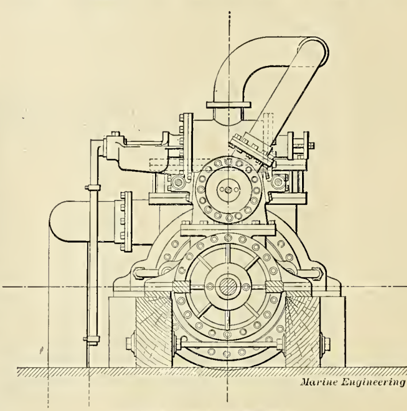
SKETCH OF THE STEAMER HASSALO FOR COLUMBIA RIVER NAVIGATION.

The hull of the vessel is wood, and was designed by Master Builder Carstens, of the O. R. & N. Co., and the machinery was built from the designs, and under the direction, of John A. Lesourd by the Willamet Iron Works of Portland.

Mr. Lesourd, chief engineer of the works, had often vainly tried to induce the owner of a proposed vessel to use more improved forms of machinery than those commonly in use, but he was unable to go forward until the order for the *Hassalo* was placed. A. L. Mohler, president of the Oregon Railroad and Navigation Co. with a commendable progressiveness, agreed to the innovations proposed, and the result is the most up-to-date stern-wheeler in the country.

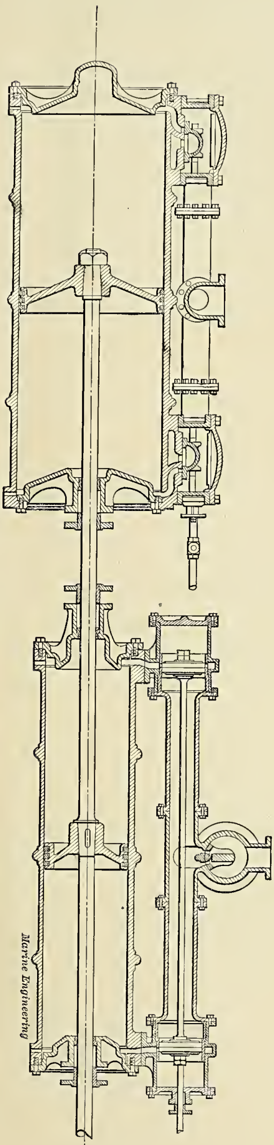
In dimensions the *Hassalo* measures: Length 186 ft., beam 30 ft., depth of hold 8 ft., load draught 5 1-2 ft. Her stern wheel is 24 ft. dia., and the buckets are 14 ft. long and 2 ft. wide. Her compound engines indicate about 3,000 horse power. On a trial run on the Willamet river, in dead water, with 150 lbs. boiler pressure the vessel attained a speed close to 21 miles an hour, and in the Columbia river she showed a speed in excess of 26 miles an hour on a two mile run. The steam pressure at the engines was then considerably below the maximum of 185 lbs. per sq. in allowed by the U. S. Inspectors, and a good deal of water was coming over. It was expected that when the steamer is in trim for regular running that she will make the 100 mile trip from Portland to Astoria, on the Columbia river, within four hours. The accompanying sketch gives a good general idea of the style of the vessel as she sits in the water.

Through the courtesy of the owners and constructing engineers we are also enabled to publish, here, drawings of the engines and boiler of the *Hassalo*. The engines are of the familiar horizontal type used in stern-wheel steamers, but are a decided step in advance of the ordinary practice in that they are compound tandem. The two engines, one on each side of the boat, are alike, and each has high pressure cylinder 22 1-2 in. dia., low pressure 38 3-4 in. dia. and a stroke of 8 ft. At the designed revolutions, 30 per minute, the piston speed is 480 ft. The exhaust, which is led direct into the stack, is intended to be about 5 lbs. above atmospheric pressure, as occasion may require, so as to force the fire sufficiently. In detail the engines are quite modern, having, for in-

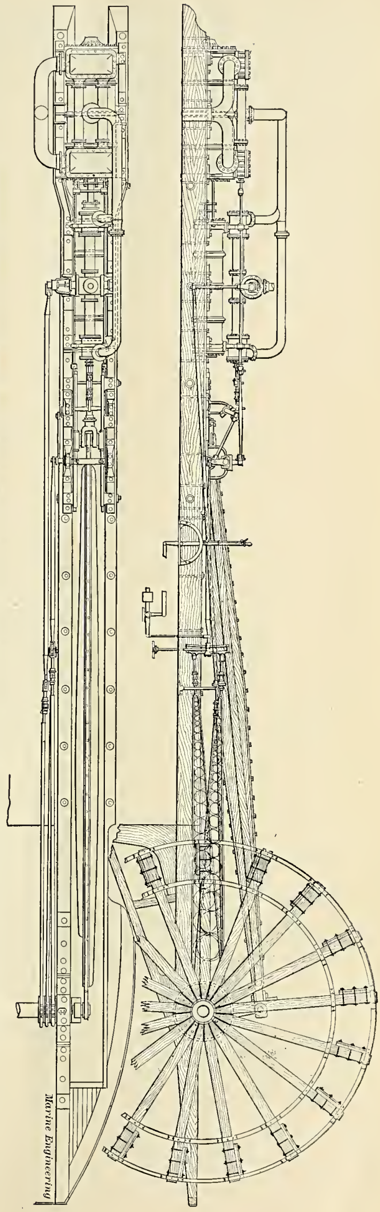


END ELEVATION OF ENGINE.

stance, dished pistons, and the best of materials have been used throughout. Piston valves are used on the high pressure cylinders, and slide valves on the low pressure. They are operated by eccentric rods, links and radius rods in the usual way, the last named actu-



SECTION THROUGH CYLINDERS OF COMPOUND TANDEM STERN WHEEL ENGINE FOR STEAMER HASSALO.



COMPOUND TANDEM STERN WHEEL ENGINE FOR OREGON RAILROAD AND NAVIGATION CO.'S STEAMER HASSALO.—PLAN AND ELEVATION.

ating rock shaft directly connected to the valve rods and stems. The cut-offs are operated by independent eccentrics in connection with a dropping arm, and the distribution of steam is effected by giving more or less travel to the valves, which is accomplished by raising or lowering the radius rod.

One man handles the engines, the reversing gear of the two sides being connected by a single lever, and a similar arrangement is provided for the cut-offs. The oiling is also chiefly done by the engineer on watch from a special oiling device or lubricator.

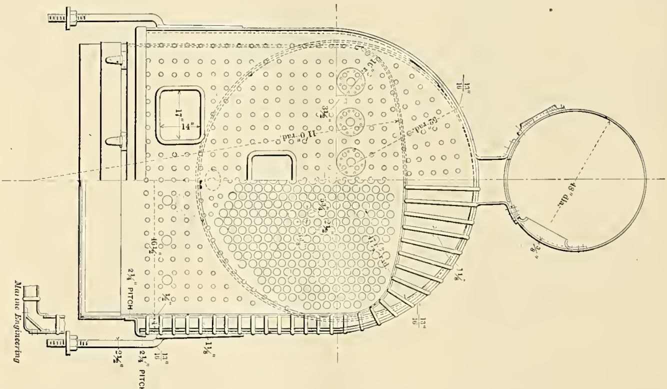
The boiler, as shown in the working drawing herewith, is of the locomotive type, and is designed to carry 187 lbs. of steam pressure per sq. in. in accordance with the U. S. rules. The shell is 3-4 in. thick, and is made of 60,000 lbs. carbon steel. It is 96 in. dia., and the length between the tube sheets is 16 ft. There are 462 tubes 2 1-2 in. dia. At the firebox ends they are provided with copper ferrules and the tubes are beaded over in the usual manner, thus forming a very substantial and tight joint. The fire-

engine room and thence to the two engines. The smoke stack is 52 in. dia. and 61 ft. high. Three duplex pumps are used for boiler feed and for the general steamer service and two handpumps, additional, are fitted.

Steering is effected by a steam gear having a steam cylinder and an oil controlling cylinder, the connections being made directly to the pilot house. A very complete electric lighting plant is also provided.

Passenger accommodation in the steamer is very luxurious; carpets, furnishings, paintings and decorations are made to harmonize in excellent taste, and the dining room is arranged so that those of the passengers who desire can use small tables, and thus enjoy a reasonable amount of privacy. Much care has been expended also upon the equipment and service in both pantry and kitchen, and experience has not been spared nor money stinted to make the vessel an up-to-date floating hotel. When put on her regular service the *Hassalo* will become, undoubtedly, one of the most popular river steamers on the Pacific coast.

ELEVATION "HASSALO" BOILER.



box is 94 in. wide, 92 in. deep to the grate bars and 11 ft. long—all inside measurements. Water spaces at the sides are 4 in. and at the back 5 in. Inside of the firebox there are six tubes 3 in. dia. reaching from near the bottom of the after end of the firebox, in an inclined position, to near the top of the front. They support specially made firebricks, acting as a baffle plate and protecting the tube sheet from the blow pipe effect of the flame, and also serving to distribute the heat more evenly. Shaking grates are used, and, as they are thus kept free from choking, cinders present no difficulty. Ashes and cinders are disposed of by a steam exhauster placed at the after end of the firebox, and connected to a hopper, in which they are raked when it is desired to throw them overboard.

To insure dry steam, a steam dome 48 in. dia. and 12 ft. long is placed on top of the boiler and attached by two welded steel nozzles securely riveted to both drum and shell. Live steam is carried direct from the dome through a stop valve, to the throttle in the

Torpedo-Boat Destroyers.—In our issue of March, 1899, we published a description, with engravings, of one of the torpedo-boat destroyers built for the Imperial Chinese Government by F. Schichau, of Elbing, Prussia. The four boats built attained rates of speed of from 35 to 37 knots in the open sea. The seagoing qualities of the boats have been very thoroughly tested on the voyage out to China, whither they were sent under their own steam. They started from Elbing, and by way of the Baltic, German Ocean, and Bay of Biscay reached Gibraltar, and thence through the Mediterranean Sea steamed to Port Said, and from there through the Suez Canal they steamed direct for Colombo, Ceylon, without touching at the port of Aden. At latest reports they had reachel Colombo, in first-class condition, having made the run of 3,500 knots without stopping. They had also a considerable quantity of coal left in the bunkers, thus demonstrating their ability to make a longer "continuous steaming" trip if necessary. Machinery repairs were practically nil.

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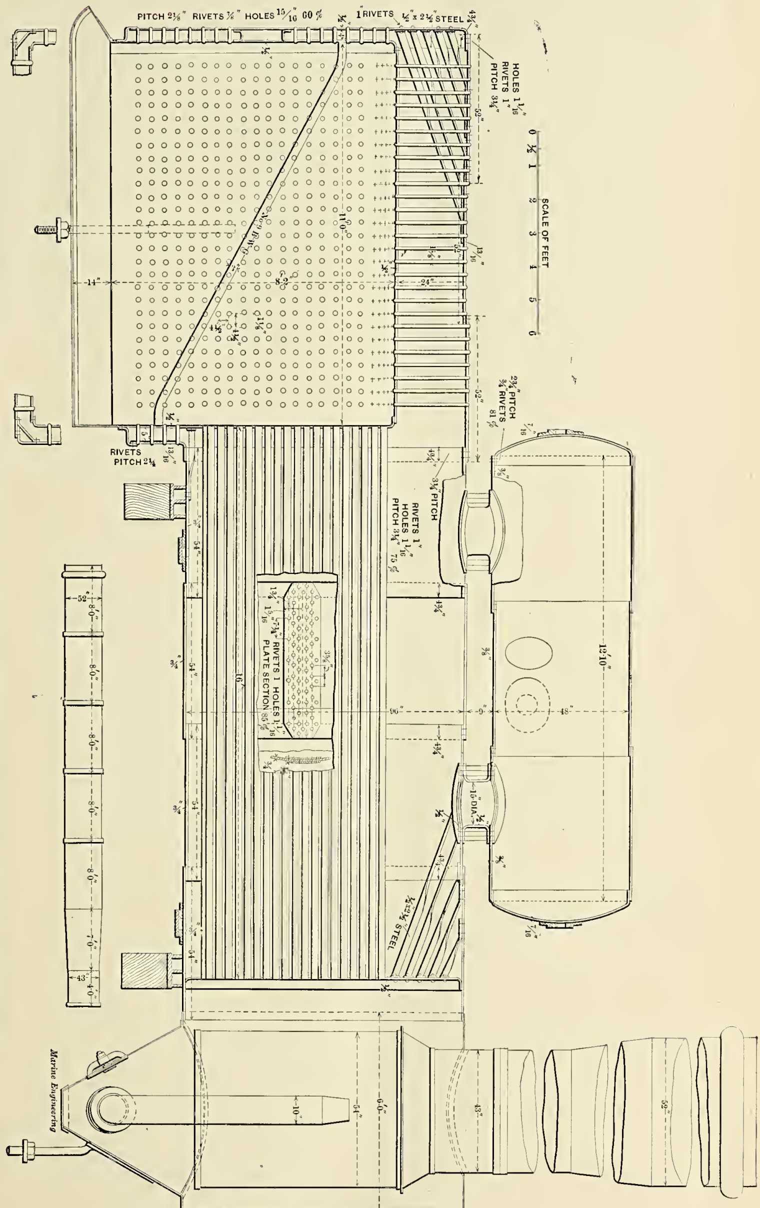


LOCOMOTIVE TYPE BOILER FOR COLUMBIA RIVER STERN WHEEL STEAMER HASSALO BUILT BY WILLAMET IRON WORKS, PORTLAND, ORE.

CONSIDERATION OF THE INDICATOR AND ITS USES ON BOARD SHIP—V.*

BY R. W. JACK.

It may appear from the somewhat lengthy calculations herewith presented that this method involves a greater amount of mathematical knowledge than the majority of our brethren possess, but it should be remembered that there is nothing really worth its possession in the view of scientific attainment which does not involve a certain exercise of the mental faculties. An interesting study crowned with success is one of the highest pleasures of the most distinctive and permanent attributes of man. But in the calculations we have made there is nothing actually required beyond a conception of the simple rules of arithmetic, and they have been worked out more in the hope that the detailed statement of principles would be better appreciated than a mere tabulated presentation of results.

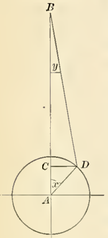


FIG. 12.

The graphic method of representing forces, velocities, distances, times, etc., and their combinations, appeals more forcibly to the understanding, and is of great assistance to a more ready perception of the applicability of mathematically demonstrable facts. The subject which we have been considering, like most others in recent teaching, is easily illustrated by curves, and we will now proceed to show, first, how a curve of velocities may be plotted out, and next, from such a diagram of velocities, how a curve of their differences may be traced which shall also represent the forces at work either in effecting an acceleration or retardation of the piston and reciprocating mechanism of an engine. Describe a circle (Fig. 13) *A*, *D*, *B*, *E*, with a radius equal to the length of the crank, and from *B*, with a length of connecting rod mark off *B F* on the center line of engine. Divide the semicircle *B*, *D*, *A* into any number of parts, say, 10 (preferably equal parts), and from each of those points on the circumference 1, 2, 3, etc., with the length of connecting rod mark the center line

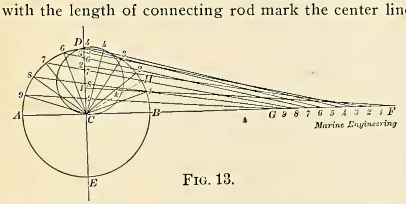


FIG. 13.

also at 1, 2, 3, etc. The latter points show the positions of the piston between the two points *G* and *F* when the crank occupies the positions shown by the corresponding numerals. From the points 1, 2, 3, etc., on the line *G F*, and through the same points on the circumference, cut the line *C D*, which will give the corresponding points, 1, 2. 3, etc. The distances C_1, C_2, C_3, etc., on the line *C D*, will represent the velocity of the piston in relation to the constant velocity of the crank pin represented by the radius *C B*, or length of crank arm. If those distances on the line *C D*, C_1, C_2, C_3, etc., be laid off on the radial lines C_1, C_2, C_3, etc., we obtain points through which a curve may be drawn representing at any position of the crank the velocity of the piston compared with the uniform rotative velocity of the crank pin, as represented by the length of crank arm, *i. e.*, for any intermediate position *C H* of the crank, the velocity of the piston is shown by the distance *Ch*, or that portion of the line *C H* enclosed by the curve of velocities. It may be interesting to observe that the curve here given also represents the value of the rotative effect on the crank pin, and if the pressure on the piston be considered constant throughout the stroke the curve will represent the turning moments on the crank, because, neglecting friction and the weight of the reciprocating parts of the engine the total work performed on the crank pin is equal to that transmitted by the piston. Bearing in mind that velocity is the equivalent of distance in a given time, the forces on piston and crank pin may, therefore, be represented by their relative velocities. But in this case we have supposed the pressure on the piston to be constant, hence this pressure being constant and the velocity of crank pin being constant, the remaining terms—velocity of piston and tangential pressure on crank pin—vary directly as each other. It may just be added that in general $P\ V = Cv$ where P and C are respectively the pressure on piston and crank pin, V and v their velocities.

From the diagram of velocities we may now conveniently trace a curve of their differences. For instance, when the crank is in the position *C B*, Fig. 13, the velocity of piston is zero, at *C*, the velocity is C_1 on the line *C D*. The difference of velocities, or acceleration between those two positions (supposing the acceleration to be constant) is, therefore, equal to C_1 on the line *C D*. Between the positions of crank C_1 and C_2 the difference of velocities is C_2—C_1, on the line *C D*, Between the positions of crank C_2 and C_3 the difference of velocities is C_3—C_2, on *C D*, and so on for every position taken. Again, describe a circle to represent the path of crank pin and divide the diameter *A B* in the same ratio as the distance *G F* (Fig. 13). From the points, 1, 2, 3, etc., Fig. 14, erect perpendiculars equal to the differences of velocities or accelerations shown on the line *C D*, Fig. 13, viz., C_1, C_2—C_1, C_3—C_2, C_4—C_3, etc. A curve drawn through the extremities of those distances will represent at some speed the forces brought into action in accelerating or retarding the speed of the piston, etc. It will be seen that the acceleration varies from a maximum at the beginning of the stroke to the point where it becomes zero, and at this point also the piston has attained its maximum velocity. The retardation of the moving parts begins at *O* and increases to a maximum toward the end of the stroke, as shown.

In modern marine engines, where there is little variation from a generally accepted standard in piston speed, length of stroke and design, the modification of the diagram necessitated by a consideration of the effects of acceleration and retardation is seldom of sufficient importance to seriously interfere with our calculations regarding the strength of the structural details of en-

*From a paper read before the Institution ot Engineers and Shipbuilders at Hong Kong.

gine design. In some special instances, where the proportional conditions are not complied with, such as excessive weight, short stroke and high piston speed, it is quite within the teaching on the subject that those abnormal conditions may cause not only inconvenience, but disaster.

There is one other modification necessary in converting the ordinary indicator diagram to one representing pressures on the crank pin of vertical engines, viz., that due to the constant weight of piston, rods, etc., The effect of this simple weight is, as a rule, very slight. It would be shown by an increase in the effective pressure on the down stroke and equal diminution on the up stroke. We would, therefore, shift the back pressure line further from the steam line on the one side, and bring it nearer on the other. For instance, in the case we have had under review the total weights were 1,200 lbs., and diameter of cylinder 17 in., the amount per sq. in. of piston area is therefore

$$\frac{1{,}200}{17 \times 17 \times .7854} = 5\ 1\text{-}4 \text{ lbs. (nearly).}$$

Turning our attention to those practical considerations which determine the shape or form of an actual indicator diagram, it may be observed that those forms are of an almost endless variety. It should be said that to produce an ideal diagram there are four distinct or critical positions of the valve with respect to the positions of the piston, and the complete figure may be said to consist of six lines, viz., 1st—the steam line, from the beginning till cut-off; 2d—the expansion line, from cut-off till exhaust opens; 3d—the exhaust line, between the terminal pressure of the expanding steam, and back pressure line; 4th—the line of back pressure or full exhaust, between the position of full exhaust and the closing of exhaust ports; 5th—the compression line, between the closing to exhaust and the opening to steam; 6th—the lead line, between the opening to steam and the end of stroke. In actual diagrams it is sometimes difficult to locate with precision the various points and the exact length of the lines. In the case of slow-running engines and with most types of patent valve gears the points may be more distinct and the lines more easily defin-

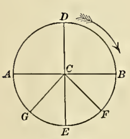


Fig. 15.

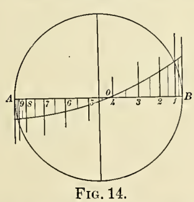


Fig. 14.

able, but as special forms of valve gear are a very small proportion of those actually at work, and because they present no very distinctive advantages over the common link motion in the distribution of steam, we may consider them together. To be able to readily explain the sometimes mysterious figure traced by an indicator, it is absolutely necessary that we should be thoroughly acquainted with the internal condition of the engine, and to the same end it is very desirable that the relative positions of piston and valve at the various points should be exactly ascertained by turning the engines a complete revolution and measuring from fixed points.

The steam line on a diagram taken from a high-pressure engine with ample area of steam pipe and through stop valves should be parallel with the base or atmospheric line. If the diagram be taken at a speed below full power and regulated by the main stop valve, the steam line will show a decreasing pressure toward the point of cut-off, due to the contracted orifice. If, on the other hand, the stop valve be full open and the diagram still shows a falling steam line, then we may conclude that the area of steam ports is insufficient for the speed of the piston, and for the valve gear with which the engine is fitted. It is here that an advantage rests with the advocates of special valve gears and of separate expansion valves. It has been sought to be shown that a loss is occasioned by the wire-drawing of the steam when using the common link motion, and that this loss may be avoided by the adoption of special valve gears giving a quick opening and a quick closing of the slide valve. It is not actually necessary that the slide valve should give a quick opening to steam, because the speed of the piston is so comparatively slow during the first part of the stroke that almost any arrangement of gear will give the requisite opening; but the steam is always more or less wire-drawn with the Stephenson link motion. This tendency is exaggerated exactly as we increase the expansion by cutting off the steam earlier in the stroke; the more steam lap we add to the valve and the further we advance the eccentric, the shorter becomes the arc of the circle which represents the opening to steam. The diagram shown in Fig. 15 will help to make this point clear. In the case of vertical engines *C D* will represent the position of the crank. If the steam be carried the whole length of the stroke, and be from *D* toward *B*, *C B* would represent the center line of the eccentric, and the outside lap of the valve would be nil. The opening to steam would, therefore, take place at *C B* when the valve is moving at its greatest velocity, and the closing would occur at *C A* when the valve has attained its maximum velocity on the return. The valve would be at its lowest extremity, and, therefore, full open on the top when the eccentric is in the position of *C E*, and the piston would have attained its maximum velocity about the position *C B*. By increasing the expansion the angle between the crank and the eccentric is increased, and as the velocity of the valve decreases from *B* to *E*, the nearer we bring the center line of the eccentric toward *E* at the instant of opening or closing to steam, the slower becomes the motion of the valve. Suppose, for example, we wish to cut off steam when the crank is at mid-stroke, that is (disregarding the effect of lead), the slide valve has to remain open during the same interval, viz., one half stroke, or an angle of 90 degrees. When the eccentric is in the position *C E* the valve will be full open to steam on the top side, so that an angle of 45 degrees on either side of *C E* will give the position of the eccentric when the valve is just opening or has just closed. *C F* would, therefore, become the position of the eccentric at the point of opening, and *C G* the posi-

tion at the instant of shutting to steam, thus showing that the earlier we effect the cutting off of the steam the slower will be the motion of the valve at that instant, and the tendency to wire-drawing of the steam consequently aggravated. The question of wire-drawing steam is not quite so simple as it appears, or as it may have been in the days of simple engines. It is really a question of economy between pure steam of a certain pressure and super-heated steam of a lower pressure. It follows that when steam of a certain pressure is allowed to pass through an orifice whose area is insufficient to allow of the full pressure being maintained the steam becomes superheated by the friction of its molecules against the sides of the passage.

Board of Life Saving Appliances.

The Board of Life Saving Appliances for the United States Life Saving Service had a meeting at the Post Office Building in Boston, in May, to consider devices and appliances proposed for use of the service. This board, which is appointed by the Secretary of the Treasury, consists of seven members including:

Professor C. H. Peabody, of the Massachusetts Institute of Technology; Captain C. A. Abby, R.C.S.; Major D. A. Lyle, Inspector of Ordinance, U. S. A.; Lieut. F. A. Levis, R.C.S.; B. C. Sparrow, District Superintendent, L. S. S.; J. G. Kiah, District Superintendent L. S. S.; N. M. Knowles, Asst. District Superintendent, L. S. S.

The meetings of the board were attended by Hon. S. I. Kimball, the General Superintendent of the Life Saving Service.

This board usually meets annually, but as there was no meeting last year an unusually large amount of material had accumulated, requiring a protracted meeting.

Among the subjects presented for the consideration of the board were: Life boats, life rafts, wagons for carrying boats, methods of launching boats, methods of signaling, oil carrying projectiles, the use of reindeer hair for life preservers, holders for flash lights and other similar matters. The devices and methods were presented by written descriptions, by drawings, or by models, and when desired the board gave hearings to those who had subjects for consideration.

It has been conclusively shown by the experiments and experience of the Life Saving Service that life rafts cannot be used from the shore, and that it is dangerous to try to force a life raft out through the surf. Again it has been found that waves which break in shallow water forming a surf are not affected by oil, even though it be used in large quantities; the conditions at sea are entirely different, and oil has long been known to have a good effect in reducing the turbulence of the water. There are methods and devices, however, which are presented by persons who have little or no knowledge of the needs or conditions of the service, and which are clearly not adapted for the use of the service. These are readily disposed of. The utmost care is required in the consideration of subjects that appear to have real merit; on the one hand there is the desire to use all means for improving the chances of saving life, and on the other the knowledge that a real test can be made only in actual service when a failure may lead to loss of life either of the people in peril on wrecks or of the life saving crews who are trying to aid them.

One of the crying needs of the service is for a thoroughly practical wagon for carrying surf boats. Contrary to the usual conception the greater part of wrecks occur not on a "rock bound coast," but on long stretches of desolate beach which in stormy weather are deserted by all except the life saving patrol. The surf boat must then be dragged on a wagon to the scene of the wreck, often to long distances over a rough and trackless country, sometimes by the aid of horses, but often by the crew themselves. The wagon should then be light, strong and simple, and must have wide tires so that loose or soft ground may be crossed with safety. The gauge or width between the wheels must not be excessive, for advantage should be taken of roads or tracks when they exist, and in many places where there is no track a wide wagon may be more difficult to handle. When the boat is brought to the beach opposite the wreck it must be unloaded, in which process under the most favorable conditions there is much lifting and danger that men may be strained and injured. Some improvement there has been in the construction of wagons and in methods of loading and unloading, but much remains to be desired. The service labors under the difficulty that the men who know what is needed are not wagon builders, and so few wagons are needed for the whole service that there is no incentive for competition among wagon builders, while the government requirements that all supplies shall be open to all bidders appears likely to take away from any builder, who may master the problem, the fruits of his labor. It would appear, however, that there should be some wagon builder who would for the good of the service learn the conditions to be met and strive to find a solution of the problem. But the problem is not an easy one, for the ideal boat wagon appears to demand a combination of a light road wagon with a traveling-crane.

A very bright readable weekly has made its appearance in London under the title of *The Skipper*. This is styled, by way of a subtitle, "A Weekly Log of Nautical Matters." No. I opens with an article by E. F. Knight, London *Times* correspondent during the Cuban war, describing how he reached Havana. Then comes a list of the current Admiralty publications, and an article on the growth of the Navy League. Following this in succession are pages devoted to yacht racing, naval matters, aquatic sports, yacht designs, news from various yachting districts, and a good deal of miscellaneous news matter of current happenings in yachting circles. A short story, book notes and letters complete the twenty-four pages of contents, which are well illustrated with half-tones. Altogether the first number is a very creditable one, and if it is an index of the purpose of the publication it will rightly belong to the group of yachting papers. The United States subscription to this paper is 30s. for twelve months and 15s. for six months. The office of publication is Clock House, Arundel street, Strand, London, W. C.

SUGGESTIONS FOR THE SELECTION OF ELECTRIC LIGHTING SETS FOR SHIP USE.

BY ALTON D. ADAMS.

Engines and dynamos for ship lighting should combine qualities of efficiency, light weight and small bulk per unit of capacity, to a high degree. The first cost of plant for ship lighting is secondary to these qualities, as it can be readily shown that the advantages to be gained from each outweigh any possible increase in cost. To consider first the importance of high efficiency in the engines driving dynamos, assume a fair cost of steam from first-class marine boilers to be twelve pounds of coal per one hundred pounds of steam, which, with coal at five dollars per short ton, amounts to three cents. With simple engines taking thirty pounds of steam per horse power hour, the steam for one hundred horse power during a year of three thousand hours amounts to $100 \times 30 \times 3000 \times .03 = 270{,}000$ cents, or two thousand seven hundred dollars.

With a compound engine taking twenty-four pounds of steam per horse power hour, the value of steam per one hundred horse power for three thousand hour year is $100 \times 24 \times 3{,}000 \times .03 = 216{,}000$ cents, or two thousand one hundred and sixty dollars.

The difference between these yearly costs is found by \$2,700.00 — \$2,160.00 = \$540.00, or fully enough to cover the extra price of a compound over a simple engine, by the saving in coal alone, to say nothing of the saving in boiler capacity, labor of firing and the space occupied by the extra coal.

As the size of engines used in ship lighting plants is usually not more than one hundred horse power, and the additional saving of triple expansion over the compound type is small, the compound engine seems best suited for these plants.

There is no such variation in dynamo efficiencies as between the simple and compound engines, but a difference of 5 per cent is not uncommon among the various electrical machines on the market, and the highest efficiencies regularly attainable should be insisted on.

By the efficiency of dynamos is, of course, meant the ratio of the electrical energy delivered from them to outside conductors, divided by the mechanical energy delivered to the armature shaft. Efficiencies given in the following table are the least that should be expected in first-class dynamos at the common speeds of direct connection and on full load:

Kilowatt Capacity...	5.	10.	15.	20.	30.	45.	60.	75.	100
Efficiency............	.75	.80	85	.88	.89	.90	.91	.91	.92

As the efficiencies of both engines and dynamos are lower at partial loads than at full load, two or more generating sets should be employed in all save the smallest plants, so that each set when in operation may be as nearly as possible at full load. To show the importance of considerations as to weight and bulk, the following table is compiled from the catalogues of several large manufacturers, showing the weights of machines of various capacities as commonly offered.

The weights in each case are for a complete engine and dynamo direct connected on a common bed-plate. This table shows the weights of different sets of the same capacity to vary, in many cases, more than fifty per cent, and this unnecessary weight with its attendant bulk takes just so much from the capacity for freight-paying cargo. Take, for example, a plant of four fifty K. W. generators with engines, which may easily be required on board a large ship for lighting and motive power purposes, as ventilating, hoisting, and mechanical draft. At two hundred pounds per K. W. the weight of this two hundred K. W. generating plant is $200 \times 200 = 40{,}000$ pounds, while at one hundred and sixty pounds per K. W. the weight is $200 \times 160 = 32{,}000$ pounds.

WEIGHTS OF COMMERCIAL LIGHTING SETS.

Make.	K. W.	Lbs.	Lbs. per K. W.	K. W.	Lbs.	Lbs. per K. W.	K. W.	Lbs.	Lbs. per K. W.	K. W.	Lbs.	Lbs. per K. W.	K. W.	Lbs.	Lbs. per K. W.
A.......	4	1600	400	15	4700	313	30	8000	266	50	10000	200	75	15500	200
B.......	4	1000	250	15	3000	200	30	6000	200	60	9700	161	80	12600	157
C.......	3	1500	500	15	5800	386	32	9000	281	36	10000	277			

The difference between these weights, or $40{,}000 - 32{,}000 = 8{,}000$ pounds, is obviously worth much more as added freight capacity during the usual life of a ship than any additional cost of the lighter over that of the heavier equipment.

In vessels intended for high speeds, as yachts and express boats, which are usually of small size and do not require an electric equipment of large capacity, the saving in weight by the lighter type of equipment is worthy of consideration for its effect on speed alone.

Suppose, for instance, that only a single set of fifteen K. W. capacity is required, the difference in weight between the lightest and heaviest type for this capacity is $5{,}800 - 3{,}000 = 2{,}800$ pounds; a dead weight which no designer of a boat intended for high speeds can afford to disregard.

It should be noted that weight per unit of output decreases with increased capacity up to a certain point, depending on the particular make of apparatus, so that when the total required capacity is not large a saving in weight may be effected by using the smallest convenient number of units.

Even the smallest weights per unit of capacity given in the table should not be regarded as the best that can be produced in this line. Further improvements are to be expected and can be secured at this time if insisted on by purchasers and engineers.

Up to the present time the engines and dynamos offered for ship lighting have been substantially the same as to weight and bulk as those used on land, except in a very few cases, and have often been the designs regularly sold for land use. In most other branches of ship equipment the necessity for the smallest weights consistent with first class construction has long since been recognized and complied with, and there is certainly ample warrant for special construction in dynamos for ship lighting and their driving engines, in order to reduce the excessive bulk and weight now common in this apparatus.

The main engines of a first-class steam vessel are of quite different construction and much less weight per unit of capacity than those commonly used on land, in spite of the fact that the type of construction in marine engines is somewhat more costly.

A vertical engine with cylinders at the top is best

adapted for dynamo driving on board ship, because of the small weight and bulk possible in this type and also its adaptation to high rotative speeds. The value of high speed of rotation is considerable in the reduction of engine weights, but more so in those of dynamos, and it seems that much is yet to be accomplished in this direction.

A very few makers of vertical engines run sizes above one hundred horse power regularly, at from four hundred to five hundred revolutions per minute, but the great majority cling to speeds not over three hundred and fifty. It seems, however, that the highest of these speeds can be much exceeded, with proper designing in respect to weights of reciprocating parts and other features. Not only does a high rotative speed tend to reduce the weight of engine frame, but also that of fly wheel, since the greater the speed the more frequent are the impulses given the wheel, and for a given diameter the greater the energy contained in its moving mass.

Coming to the question of dynamos, the method of driving by direct connection on a common base with the engine seems much preferable to any other. Something may be saved in weight by belt driving, but the loss of space, convenience and reliability render this method unsuitable for use on board ship. All sorts of flexible couplings between the engine and dynamo should be avoided and a stiff, continuous base with bearing outside of the commutator end of the armature shaft insisted on in every case. Two methods of rigid connection between the armature of dynamo and the engine shaft have been in general use. In one method the armature has its own shaft, which is provided with half of a flange coupling on the end next to the engine; the engine shaft carries the other half of the flange coupling and is joined to the armature shaft with through bolts; the other method of connection is to extend the engine shaft over that part of the base occupied by the dynamo and through the bearing at commutator end of armature, the armature for this construction being built with its commutator on an independent sleeve, which can be put on the engine shaft at will.

The last named arrangement, with continuous engine shaft through all the bearings is obviously stiffer and more certain of alignment, and should be selected in all cases. The means for electric contact at the commutator require more care and attention than all other parts of the dynamo together, and the best practice having settled on the carbon brush for this purpose, nothing else should be accepted. Numerous makes and varieties of carbon brushes will be found, however, and some give vastly more trouble than the copper brushes used in the older practice.

Carbon in any form has a much higher electrical resistance than copper, and the friction of most carbon brushes on commutators is greater than when copper is used; both these conditions tend to produce additional heat at the commutator, and this is one of the most serious troubles the dynamo tender has to avoid. There is much difference in carbon brushes, both as to their electrical resistance and friction on copper commutators, and hard brushes which have a rough feel on their freshly dressed or broken surfaces, also those which have mysterious lubricating compounds pressed or worked into them, should be avoided.

By far the most satisfactory brush for electrical machines is made of pure graphite with a thin coating of copper on the outside, and no oil or grease of any kind mixed in it. Such a brush can be used on a commutator with absolutely no oil or commutator compound applied, and will cause less trouble and wear of the commutator than any other brush.

The several forms of commutator segments are of, either, cast, drawn or drop-forged copper; the drawn and drop-forged kinds are practically the same as to electrical conductivity and wearing qualities, while cast copper is not only inferior in these respects, but has the unfortunate quality of developing blow and sand holes occasionally when segments are partially worn out. It seems strange that with the known inferiority of cast copper, some makers persist in its use, especially in view of the fact that all of the large and better manufacturers have long since adopted the drawn and drop-forged varieties.

Coming now to the general types of dynamos in use for ship lighting, a great variety exists. English ships are, mostly, supplied with dynamos of the bi-polar type of the utmost simplicity, having but one or two magnet coils, easily understood armature winding, comparatively small commutator and but two sets of brushes. Only a few bi-polar dynamos, in the smallest sizes, are offered by American makers for direct connection in ship lighting, the types having four, six, eight and even more poles being in favor with makers on this side of the Atlantic. There is no doubt that with equally good design something is gained in weight by the use of four instead of two poles, and this tendency operates in a less degree with larger numbers of poles up to a certain point. When it is held in mind, however, that each additional pair of poles involves two more magnet coils, two more sets of brushes and some additional complication of armature winding and commutator, it is a question whether the multiplication of parts beyond four-pole machines is warranted in dynamos for ship use. Intelligent design should aim to adapt every device, in some measure, to the conditions of its use, and it seems fairly evident that a machine so little understood by the ordinary mechanic, as a dynamo, may reasonably be spared some complications, when its repair may be necessary at some out of the way port, that would be quite admissible were it intended for office-building lighting in New York.

Sufficient skill to rewind and repair dynamos of the simplest types is now fairly common among mechanics, but any serious trouble with the commutator or windings of an eight or ten pole dynamo would be very apt to wait until the experts of an electrical shop could reach it.

That portion of a dynamo which usually fails first is the insulation which separates the windings from the iron parts. This insulation is in the main of fibrous materials, as cotton cloth and paper, though mica is used at some points. When dynamos are in use the insulation is constantly subject to electric strains and heat, and its ability to withstand the former depends much on the degree attained by the latter.

Cotton cloth and paper deteriorate rapidly under heat of from 400 to 500 degrees F., and to quite an extent from 200 to 400 degrees F., so that it is desirable that the parts of a dynamo shall not become hotter than about 200 degrees F. in regular use. A rise in temperature above surrounding air is commonly allowed for dynamos to be used on land, under continuous run at full load, of from 70 to 90 degrees F., which allows the air to reach 110 to 120 F. before the parts of the dynamo reach 200 degrees F., and this point is seldom exceeded.

On ships, however, engine-rooms usually become hotter than is common on land, and a lower rise in temperature should be provided for in ship dynamos. The United States Navy regulations allow only fifty degrees F. rise in temperature of dynamos under continuous run at full load, and the life of dynamo windings on merchant ships would no doubt be increased by similar requirements.

Recommendations are now heard in some quarters of enclosed dynamos for ship lighting, but while the enclosed features have much value for small electric motors that must be located in exposed, dusty or dirty places, their desirability for large dynamos in ship engine-rooms, where they may be kept dry and clean, is very questionable.

It should be held in mind that if a given dynamo is enclosed in an air-tight case, its capacity to dissipate heat is greatly reduced, so that its higher temperature will do more harm to its insulation than any dirt that may accumulate in a reasonably clean engine-room. If the dynamo case has a number of fine screens, quite a portion of the dirt in the air gets through them, and as the machine in this case is seldom cleaned, it is apt to become dirtier than if entirely open and given a reasonable amount of care. On the other hand, a new machine designed to operate at a low temperature in an air-tight case is certain to be much heavier than one having the parts in which heat is generated exposed.

Durability and simplicity are two points which should be ever present in the design or selection of an electric ship-lighting plant, the care of which, in small vessels at least, will be entrusted to the engineer or oiler on watch, additional to his regular duties; and even in large vessels it is not likely that the engine-room staff will have the same amount of time to devote to the care of the electrical machinery, in running, that would be expended in a shore plant of any magnitude.

Tug Boat Gypsum King.—A very successful builder's trial of this vessel took place June 17 on Long Island Sound. She is a large powerful sea-going vessel built by the Burlee Dry Dock Co., Port Richmond, Staten Island, for the J. B. King Co., of New York, and she will be employed in towing barges between New York and Windsor, Nova Scotia. The new tug is of the following dimensions: Length, 165 ft.; beam, moulded, 29 ft. 4 in.; depth of hold, 19 ft. 3 in. She is fitted with triple expansion engines, with cylinders 17 in., 27 in. and 45 in. dia. and 36 in. stroke, furnished with steam at 175 lbs. pressure by two Scotch boilers 13 ft. dia and 11 ft. long. The barges to be towed will be over 200 ft. in length and each will carry 2,100 tons of gypsum rock on about 17 ft. draught of water.

STEAM PIPES ON VESSELS—MATERIALS USED AND CAUSES OF FAILURES.—I.*

BY J. T. MILTON.

In 1895 the author had the honor of reading a paper on "Steam Pipes" before the members of this institution, and it is thought that some further remarks upon the subject would not be out of place, in view of its increasing importance. When it is remembered that there are in existence about 17,000 steam vessels of above 100 tons register, and that in any vessel the failure of a steam pipe may possibly lead to her total disablement, and that every day sees several additions to the number of vessels in which steam pipes of larger size and working at higher pressure are used, it will be realized that the subject is one which demands the attention and consideration of marine engineers.

When dealing with matters in general use, or coming under common observation, there is no doubt that a few failures teach their lessons more emphatically than a large number of successes; and, therefore, in this paper reference will be made to some of those cases of accidents to steam pipes which have been publicly inquired into under the provisions of the Boiler Explosions Acts of 1882 and 1890. A summary of all the cases which have been so inquired into is given in the appendix to this paper, but it must not be thought that these are all the serious accidents to steam pipes which have happened, as many failures occur which are repaired without the facts becoming known to the officials whose business it is to hold these inquiries.

CAUSES OF FAILURE.

It will be seen from the appendix that in none of the cases has failure occurred through original weakness of the pipes themselves; that is to say, through their being originally made too thin. In the majority of cases the troubles have arisen through the design of the pipes having been at fault. In fourteen out of the sixty-eight cases referred to, the accident occurred through there being no provision for draining the collection of condensed water from the pipes; while in no less than thirty-eight, or more than half of the total accidents, there was insufficient provision for expansion and contraction, and for the motion due to vibration, etc., and in many of these cases similar accidents had previously occurred without being inquired into. In a few cases the explosions occurred either through original defective workmanship or through defects which subsequently developed in the pipes.

MATERIALS FOR PIPES.

It will be well to first consider the materials used for pipes before dealing with the question of design, as the latter has to be made to suit the materials employed. The materials in general use for main steam pipes are copper, used either in the form of seamless or of brazed tubes; wrought iron, generally lap-welded; steel, also lap-welded, and sometimes fitted in addition with a riveted butt strap covering the welded joint; cast iron has been employed in a few cases, as also has seamless steel. Small steam pipes for auxiliary purposes are almost invariably made of copper. In a few

*A paper read at the Fourteenth Session of the Institution of Naval Architects, London.

cases, however, they have been made with seamless steel.

COPPER FOR STEAM PIPES.

Of these materials copper is by far the most common. Formerly nearly all copper pipes were made from sheet copper, with brazed lap joints; straight pipes, except in the largest sizes, being made with one seam. Bends of small pipes are generally made from straight tubes; large bends, however, are made from two sheets, worked into shape by the coppersmith, and brazed along two seams. Recently, improvements in manufacture have enabled seamless tubes to be made at reasonable prices, so that, up to about 6 or 7 in. diameter, most steam pipes are now made from seamless tubes, which are bent by the coppersmith into the shapes required. Generally the flanges are brazed on the pipes, but in a few cases special patent flanges are adopted, enabling brazing to be dispensed with. That want of confidence is felt in copper pipes by the Admiralty and by some engineers is shown by their wrapping them with copper wire, or by steel wire rope, or by fitting wrought iron bands at short distances apart along their whole length.

Copper probably owes its present extended use mainly to custom, and its first selection was, no doubt, due to its non-liability to corrosion and to its great ductility. The latter, however, is a variable quantity, depending largely upon the treatment to which it has been subjected, and depending also upon its composition. When copper has been thoroughly annealed it is very soft, and a very low stress, say, even less than two tons per square inch, will produce a slight permanent set. As the stress increases the deformation increases more rapidly, and at a tensile stress of from 13 to 14 tons per square inch, calculated from the original section, fracture will take place. In the case of good copper, which has been previously properly annealed, the elongation in 8 in. will be about 30 to 40 per cent. If the copper is stressed to any less amount than its ultimate strength and the load released it will be found that the stress has *hardened* the copper, and that the metal will then be practically elastic up to nearly its original load, less stress than this producing no further permanent elongation. If, after this hardening, the copper is again annealed it will behave as it did in its original annealed state, a low stress again producing a permanent elongation.

STRENGTH OF COPPER PIPES.

The effect of hardening upon the extension, and the apparent ultimate strength of copper, is well illustrated by the accompanying autographic diagrams of tests made by Professor W. C. Unwin on specimens of cop-

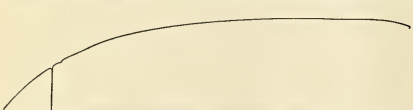


FIG. 1.

per, one being annealed and the other fairly hard. Fig. 1 represents the tests on the annealed, and Fig. 2 upon the other specimen. In these figures vertical distances represent the total load upon the specimens, and horizontal distances represent upon a scale of twice the full size the elongation in an original length of 8 in.

The particulars of the actual tests are given in the table below:

Dimensions. Width.	Dimensions. Thick.	Section.	Stress at Elastic Limit.	Maxim. Stress in Tons.	Elongation in 8 in.	Remarks
In.	In.	Sq. in.	Tons per sq. in.	Per sq. in.	Per ct.	
1.503	0.188	0.2826	1.769	13.03	48.13	Annealed
1.498	0.193	0.2891	15.56	16 13	17.88	Hard.

The nearly vertical line at the commencement of each curve shows that the elasticity of the material was at first nearly or quite perfect; the falling away of the curve from the vertical portion shows the elongation which takes place after the elastic limit is passed. In the

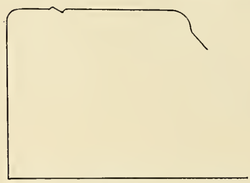


FIG. 2.

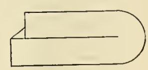


FIG. 2A.

case of the hard copper it appears that after the material has commenced to stretch the application of the same load continues to elongate it. In the case of the soft specimen, a low stress commences to stretch it, but until nearly half of the total elongation is reached each successive increment of stretch requires a higher stress to produce it.

The break in the curve was produced by relieving the stress after an extension of one-third of an inch. On the load being re-applied, it will be seen that the elastic limit had been raised by the previous testing from 1.769 to 6.9 tons per square inch.

The lower ultimate strength shown by the annealed piece of copper is due to the stress being calculated from the original area, the great extension of the soft specimen causing more contraction of area than occurs with the harder specimen. If the stress actually borne by the two pieces is referred to the actual reduced section at the moment when each is withstanding the maximum load it will be found that the results are approximately equal in these two cases. This shows the importance, when testing copper for the purpose of ascertaining its quality, of being careful that the specimen is properly annealed before the test.

Hardening of copper may be produced in other ways than by direct tension. Copper wire is hardened by continual bending and straightening; sheet copper is hardened by hammering or by cold rolling; pipes may be hardened by planishing or by being hammered or bent whilst they are "loaded," and copper tubes are always hardened when they are drawn on a draw bench either to a smaller diameter or to a thinner gauge. In whatever way copper is hardened, its ductility is correspondingly lessened, and in all cases the hardening may be

removed by "annealing," that is, by raising it to a bright-red heat, and either quenching it in water or allowing it to cool gradually.

Commercial copper, as used for other than electrical purposes, is rarely pure, or even nearly pure. The effects of some of the common impurities, such as arsenic, nickel, and silver, are supposed not to be detrimental; while, on the other hand, antimony is objectionable, and bismuth, even in small traces, is exceedingly prejudicial. The usual workshop test for the quality of copper is to cut off a portion of the pipe or sheet and anneal it, when it should stand bending quite close, without a sign of cracking, as shown in the illustration, Fig. 2a. The edges also should stand thinning to a knife-edge without crack when hammered to a scarf joint form with a lap of about three or four times the thickness of the copper.

BRAZING COPPER PIPES.

Brazing solder is composed of copper and zinc, in about equal proportions; occasionally, however, one-half per cent of tin is added to the mixture. The mixed metal is first cast in iron ingot molds, then it is reheated to a certain temperature, considerably below red heat, at which it becomes brittle and is pounded up with an iron pestle and mortar. The addition of the small quantity of tin is said to facilitate the pounding. It thus appears that at a temperature intermediate between that of the steam and a red heat the solder becomes brittle, and unfit to sustain any stress.

It is usually considered that the brazing solder, like copper, is not liable to corrosion, and in the majority of cases in which brazed copper steam pipes have been cut up after many years of service the brazing is found to be in as good condition as the copper. In a few cases, however, the brazing of copper steam pipes has been found to have deteriorated in use to an alarming extent. Attention was first drawn to this in the case of the fatal explosion of the steam pipe of the S. S. *Prodano,* referred to in the appendix as No. 1,033. After the official inquiry into the matter this case was investigated by Professor Arnold, of Sheffield, whose report was published in *Engineering,* Vol. LXV. p. 468, and *The Engineer,* Vol. LXXXV, p. 363. Professor Arnold showed that the brazing in this and in another case submitted to him at the same time had deteriorated by the whole of the zinc in some parts of the solder becoming oxydized, the copper remaining in the form of a spongy metallic mass, the pores of which were filled with oxydized zinc. He attributed this result to electrolytic action set up by fatty acids produced in the boiler or in the steam pipe from the decomposition of organic oils, as he found and separated these organic acids from the deteriorated solder. Since attention was drawn to these cases a few other steam pipes have been found to have been similarly depreciated in their brazing.

It is worthy of note that experience with Muntz metal exposed to the corrosive action of sea water shows that a somewhat similar deteriorization of the zinc takes place. It is said that this is prevented if a small quantity of tin is added to the mixture; but in the cases of the brazing solder investigated by Professor Arnold, one specimen, which originally contained one-half per cent of tin, was equally affected to that composed of copper and zinc only.

RECENT PUBLICATIONS.

MECHANICAL MOVEMENTS, POWER DEVICES AND APPLIANCES, *used in Constructive and Operative Machinery and the Mechanical Arts.* By Gardner D. Hiscox, M.E. Norman W. Henley & Co., New York. Size, 6 1-2 by 9 1-2. Pages 396. With 1,649 engravings. Cloth, $3.00.

This is a handy book of reference for the use of Inventors, Mechanics, Engineers, Draughtsmen, and others interested in any way in mechanics. For the first named it is specially valuable, for while it does not pretend to cover all the known forms of applications of mechanical principles, yet it treats of so many different mechanical forms and their uses that it is a good index of existing practice. A reference to its pages would often save the inventor many hours of useless study in working out what has already been accomplished. And, contrariwise, it will be found of much use by the designer or draughtsman, who can, in its pages, get ideas how to work out some problems in motion which may come up in the routine of design. The book is divided into sections as follows: The Mechanical Powers, Transmission of Power, Measurement of Power, Steam Power, Steam Appliances, Motive Power, Hydraulic Power and Appliances, Air Power Appliances, Electric Power and Construction, Navigation and Roads, Gearing, Motion, Horological, Mining, Mill and Factory Appliances, Construction and Devices, Draughting Devices and Miscellaneous Devices. These sections are subdivided into groups of similar appliances, each appliance being briefly described in a single paragraph, and illustrated, for the most part, with a line drawing. Within the limits of its size the book is very complete and for the greater part up-to-date.

The London weekly publication *The Yachtsman* has been increased in size, and typographical improvements have been adopted which make it now about the most attractive looking marine paper published in the United Kingdom. The number of illustrations has been increased also, and the publishers announce that it will be "more then ever interesting, practical and up-to-date and that the price (six cents weekly) will remain unaltered." With each issue a very fine half-tone supplement, printed on heavy coated paper, is issued. The subject is usually a yacht under full sail at sea.

A new monthly publication has been started in London under the title of *British Refrigeration and Allied Interests,* which for a new journal is one of the most complete we have received. It is upon the lines of a newspaper rather than a technical paper, and has been so arranged doubtless to meet the special requirements of the field it proposes to cover. As might be supposed, there is much space devoted to the shipment of meats on ocean vessels, and the terminal facilities for handling cargoes. Technical matters, while not put in the forepoint, are, however, not neglected, as in a recent issue there appears a special article on "Liquid Air" by Dr. W. Hampson, M.A., Oxon., which is adequately illustrated. The foreign subscription to this periodical is only 5s. a year, and to those interested in the marketing of perishable goods it would be very useful. The office of publication is Leadenhall House, London, E. C.

U. S. Torpedo-Boat Destroyer Stringham.

The U. S. S. *Stringham*, the first torpedo boat destroyer completed on the Atlantic coast, was put into the water at Harlan & Hollingsworth's yard, Wilmington, Del., on Saturday, June 10. The launch was particularly successful and though it took place in a drizzling rain the enthusiasm of the hundreds gathered about the ship was not dampened, for the boat took the water to the accompaniment of hearty cheers and well wishes. She was christened with the customary bottle of wine by Miss Edwina Stringnam Creighton, of Morristown, N. J., a granddaughter of the late Admiral Silas H. Stringham.

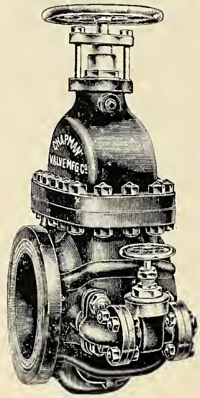
In our issue of February last a description of this vessel was given with drawings of the engines and hull. Her construction was authorized by Congress in the Act approved March 3, 1897, and the contract for her construction was signed with the Harlan & Hollingsworth Co., of Wilmington, Del., July 29, 1897. The keel was laid March 21, 1898, and the contract date of completion was set at July 29, 1899. The price for hull and machinery, exclusive of ordnance and outfit, is $236,000. She is 225 ft. long, 22 ft. extreme breadth, and at 6 ft. 6 in. mean draft displaces 340 tons. The design in its general features follows the English type of boat, but it is not a close copy of foreign plans. She has four Thornycroft water tube boilers, and three stacks, the two middle boilers having a common stack. The engines are twin screw, vertical inverted, triple expansion, designed to indicate 7,200 horse power, which is expected to drive the boat at least at the guaranteed rate of speed of 30 knots. Her allowance of coal at the normal draught of water is 35 tons, and her bunkers will stow 120 tons. She carries an unusually heavy battery for boats of her class, as in addition to two deck discharging tubes for 18-in. Whitehead torpedoes, she mounts seven 6-pounder R. F. guns, one on top of each of the two conning towers, and the other five on the deck between the conning towers. The officers' quarters aft consist of a cabin and state room for the Captain, a state room each for the executive officer and engineer, and a mess room, abaft which is a pantry and bath room. Forward of the Captain's quarters is a compartment with four berths for petty officers, and one with six berths for machinists. Forward of these is the firemen's quarters with twelve berths. Forward of the firemen's quarters is the engine room, occupying the full width of the boat for 28 ft., and then come the boiler compartments and coal bunkers, which absorb 73 ft. of the length of the boat. Forward of the boilers is the galley and then the crew's quarters, with twenty folding berths, and in the extreme bow the windlass compartment. A turtle back is built from the forward conning tower to the stern, and the latter has a sharp rake instead of being plumb as usual.

The boat was launched with the machinery in position and will soon be sent on her preliminary trial. She is one of the three destroyers contracted for in July, 1897. The other boats of this trio are the *Bailey*, under construction at Morris Heights, N. Y., and the *Goldsborough*, building at Portland, Ore. They are of smaller dimensions.

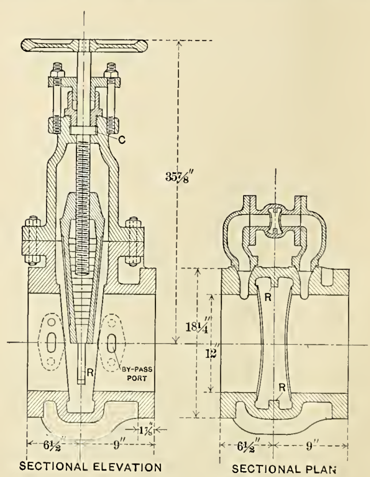
IMPROVED APPARATUS.

Steam Valve for Russian Battleship.

The accompanying cut shows a special 12 in. high pressure steam valve, recently built for one of the new Russian battleships by the Chapman Valve Manufacturing Company, of Indian Orchard, Mass. This valve is designed for a working steam pressure of 256 pounds per sq. in., and is made entirely in bronze, including the hand-wheels, bolts, studs, and nuts. The valve is of the standard double faced solid wedge plug type originated by this company, and is of extra heavy pattern with ribbed body. The gate, or plug, is in one piece, made hollow and wedge shaped or tapering, heavily ribbed internally. The seats are integral with the body and at an angle of 10 deg. with each other. To insure perfect alignment with the spindle, the plug is guided by ribs or splines in the body (*R.R.* Figs. 2 and 3) which engage with grooves in the edges of the plug and prevent it from turning or coming into contact



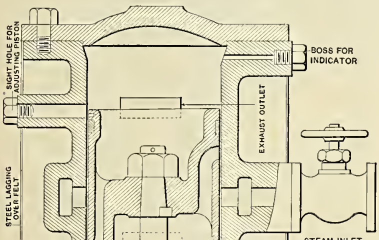
CHAPMAN VALVE.



SECTIONS OF CHAPMAN VALVE.—FIGS. 2 AND 3.

with its seats while opening or closing. The valve is of the inside screw type and the plug rises and falls on the spindle, its upper portion being threaded to form a nut for the screw on the lower end of the spindle.

The spindle revolves but does not rise, being held vertically by the thrust collar *C*, and the valve thus requires much less room for operating than the outside screw type, in which the spindle rises with the plug. To furnish means for warming the pipes and to equalize the heavy pressure (about 29,000 pounds on 12 in. circle) before opening, the valve is provided with a special 1 1-2 in. by-pass, as shown in the engravings. The by-pass valve is of the same general type as the main valve. The by-pass pipes are of heavy bronze, with flanged connection to the by-pass valve and ground joint connection to the main valve body. The



JOY'S ASSISTANT CYLINDER.

main valve body is of special construction, being very short on one end. The stuffing-box is of ample size and has bolted follower. The wheels of both main and by-pass valves are of polished bronze. The bolts and nuts are of Tobin bronze, with navy bronze nuts. All other parts are of navy bronze. The neck of the valve cap is tapped for a 1-2 in. drip pipe, as shown in the woodcut. The valve was tested both open and closed under a hydraulic pressure of 500 lbs. per sq. in., and was absolutely tight under both conditions. The shipping weight of this valve was about 1,300 pounds. This company makes a specialty of high-pressure work, and also of valves for special uses, such as angle valves, drip valves and ammonia valves. These are chiefly of the "gate" type.

Joy's Assistant Cylinder.

In large engines with heavy slide valves, or in small, fast running engines where the momentum forces of the steam valves are considerable, the employment of some form of balancing piston is indicated. A modern development of the ordinary balance cylinder which has been widely adopted is the Joy assistant cylinder, a sectional drawing of which is here reproduced. About ten years ago this apparatus was first applied to the engines of a British war vessel, and though in rather an imperfect form, the advantages of it were so apparent that the inventor continued his investigations and experiments, until in time the present type was evolved. It is the purpose of this apparatus to support the weight of the valve, and to relieve the eccentrics and valve gear, as much as practicable, of the work required to move the valve. The apparatus, as plainly shown in the engraving, consists of a steam cylinder in which a piston works, this piston being secured to a prolongation of the main valve stem. The cylinder has steam and exhaust ports, and with the working piston forms in effect a little steam engine. Steam is admitted in the center of the cylinder and passes through ports cored in the piston to the ends. The piston in traveling opens the exhaust ports in the body, alternately, and the operation of the piston is thus automatic. The steam supply can, of course, be throttled, though when the main engines are linked in the assistant cylinder will be automatically and simultaneously affected. Power for "assisting" the main valves is obtained, of course, by the admission of live steam to the assistant cylinder, and the ports are so arranged that cushioning at the ends of the stroke in this cylinder absorbs the forces due to the momentum of the valve. In cases where the assistant cylinder has been long in use the wear on the valve gear has been very materially reduced, and the wear that has taken place has been very evenly distributed over the eccentrics, both top and bottom. Another advantage claimed for this apparatus over the ordinary balance cylinder is a substantial decrease in weight, a matter of special importance in vessels of the torpedo destroyer type. Owing to the greater efficiency of this apparatus a smaller size cylinder can be used. An instance of this is quoted where a 14 in. dia. balance cylinder, which, with piston and cover, weighed 604 lbs., was replaced by a Joy assistant cylinder of a total weight of 340 lbs.—a saving of about 56 per cent. The use of this assistant cylinder costs something in steam, but at the same time the work performed by the cylinder is taken off the main engines, and the direct application of steam to the movement of the main steam valve gives, necessarily, a higher efficiency than the same amount of energy applied through the roundabout way of the main piston, crank shaft and valve gear. A list of applications of this gear to modern vessels shows totals of 182 warships, representing 513,450 I. H. P., and 162 merchant vessels, aggregating 329,410 I. H. P. Such merchant lines as the P. & O., Cunard, American, North German Lloyd, Donald Currie and Orient are users, and among the navies are the British, Italian, Austrian, Spanish (Cristobol Colon), and Portuguese. The American representatives of the inventor are Thorpe, Platt & Co., 97 Cedar street, New York.

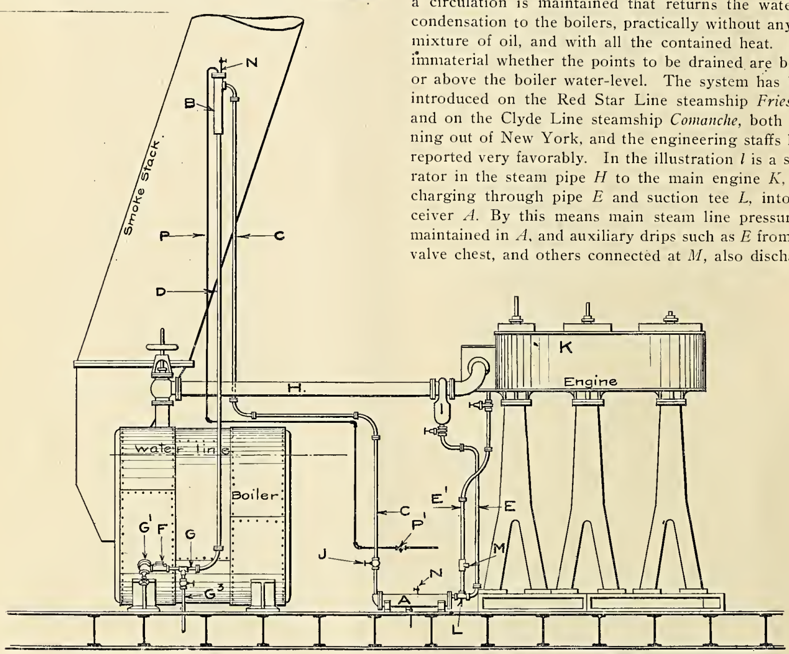
Ball Bearing Sheave Wheel.

Our engraving shows the Parkin Ball Bearing Sheave Wheel for use in tackle blocks, elevators, doors, slides and in all kinds of pulleys. The sheaves rotate without strain on the pin, prevent torsion on the straps, and remain clear at the sides of the shell when moving at any angle. For the equipment of yachts and sailing vessels this sheave is especially valuable, as running sails can be hoisted with considerably less labor than with the old-fashioned blocks, and, in dropping the sails without the use of a downhaul, the easy working of the blocks gives rapidity of action. Due to the easy running, the makers claim that where these blocks are used a great saving in ropes and tackle will result, and especially so in the case of heavy hoisting. As a result of practical tests a naval officer of prominence recently reported on these blocks as follows: "In my opinion the tests show that the Parkin Bushing is superior in simplicity, durability, and ease of working to the bushings now in Government use." The device is not complicated at all, for the sheave can be quickly taken apart by any ordinary seaman. The manufacturer is the Penna. Block Co., S.E. Cor. Seventh and Cherry streets, Philadelphia, Pa.

P·RKIN BALL BEARING SHEAVE WHEELS.

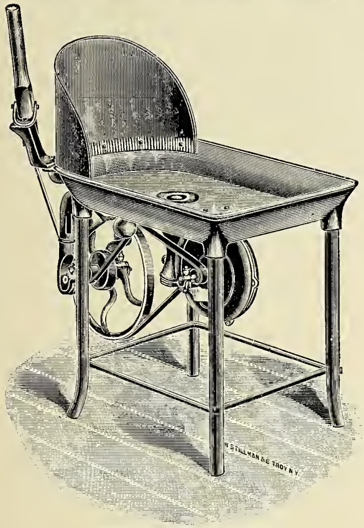
Holly Gravity Return System.

To automatically get rid of the accumulation of water in steam pipes and cylinders and valve chambers, in a steam vessel while under steam, is the object sought to be attained by the use of the Steam Loop and Holly Gravity Return System, a sketch of which is printed on this page. This system has met with great success in the shore plants, where it has been very extensively introduced. The manufacturers make strong claims for the effectiveness of this apparatus, and point to particular cases where its application has produced very beneficial results. On the score of economy alone its use is advocated, as it continuously conveys the water of condensation back to the boiler, thus utilizing this store of heat, the temperature of return water being as high as 300 deg. Fah. In this system advantage is taken of the force of gravity and the tendency of gases to flow to the point of lowest pressure. It continues in operation so long as any pressure is maintained, and independently of the use of steam for power purposes. Without the aid of feed pumps or other moving parts a circulation is maintained that returns the water of condensation to the boilers, practically without any admixture of oil, and with all the contained heat. It is immaterial whether the points to be drained are below or above the boiler water-level. The system has been introduced on the Red Star Line steamship *Friesland* and on the Clyde Line steamship *Comanche*, both running out of New York, and the engineering staffs have reported very favorably. In the illustration *I* is a separator in the steam pipe *H* to the main engine *K*, discharging through pipe *E* and suction tee *L*, into receiver *A*. By this means main steam line pressure is maintained in *A*, and auxiliary drips such as *E* from the valve chest, and others connected at *M*, also discharge



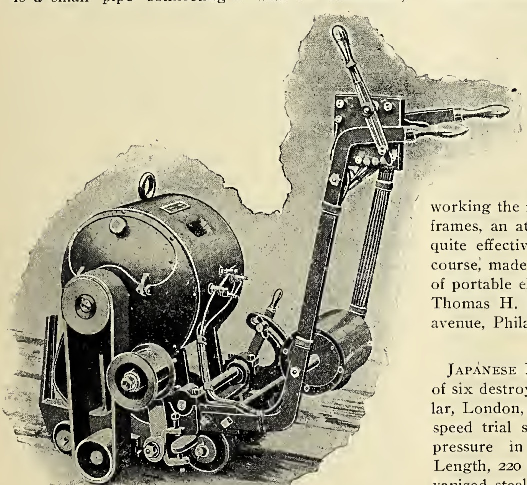
STEAM LOOPS AND HOLLY GRAVITY RETURN SYSTEM IN STEAMSHIP.

into *A*, through side opening of suction tee *L*. The riser *C* connects with the discharge chamber *B*, and



EMPIRE PORTABLE FORGE.

thus delivers back to the boiler or boilers through *D*. *P* is a small pipe connecting *B* with the condenser,



DALLETT PORTABLE DECK PLANER.

through a special reducing valve P^1, so that a slight fall in pressure may be maintained in *B*, to insure free circulation of the system. *NN* are air vents, and *G* is a blow off. Other valves shown are for properly controlling and operating the system. The system is controlled by Westinghouse, Church, Kerr & Co., Havemeyer Building, New York, who will be pleased to furnish fuller particulars on inquiry.

Empire Portable Forge.

For use in the open, where a hood is not required, the portable forge here illustrated has been specially designed. The hearth, which measures 23 in. by 35 in., is supported on stout iron pipe legs. Blowing is effected by a reciprocating motion of the handle at the back, so that the helper can readily urge the fire with one hand and manipulate the tongs with the other. The height of forge is 30 in. and the weight 145 lbs. It is guaranteed to produce a welding heat on 3 in. iron in seven minutes. For boiler, bridge and ship work it is especially adapted. Driving is effected by belts, and gears are thus avoided. The bearings are fitted with brass boxes and oil cups throughout, and the friction clutch is of the noiseless variety. If desired this type of forge can be had with attached water tank. The forge is manufactured by the Empire Forge Co., Lansingsburgh, N. Y.

Portable Deck Planer.

A novel machine for finishing wooden decks is shown in the engraving of what at first glance appears to be a freak lawn mower. This machine, in fact, not only resembles a grass cutting machine in appearance but in operation. The cutter head which carries the planing knives is belt driven from the pulley of an enclosed electric motor, which is carried on the top of the frame forward of the operator. The entire machine is carried on wheels fitted with roller bearings, and when the operator pushes the machine ahead the knives come in contact with the planking, and when he hauls the machine in a sternward direction the knives are raised off the deck. There is a ready adjustment for the regulation of the depth of cut, and the stopping and starting switch is very conveniently placed at the handles. For working the machine at the sides of a ship, close to the frames, an attachment is provided which is said to be quite effective. Connection with the machine is, of course, made with wire in the manner usual in the case of portable electric appliances. It is manufactured by Thomas H. Dallett & Co., York street and Sedgley avenue, Philadelphia, Pa.

Japanese Destroyer Akebono.—This vessel is one of six destroyers now building by Yarrow & Co., Poplar, London, for the Japanese Government. On her full speed trial she made 31.159 knots with 1 1-2 in. air pressure in the stokehold. Her dimensions are: Length, 220 ft.; beam, 20 ft. 6 in. She is built of galvanized steel containing a proportion of nickel, a material having a stencil strength of 40 tons. Her armament consists of two 18 in. topedo tubes, one 12-pounder, five 6 in. rapid fire guns. She is propelled by twin screws driven by triple expansion balanced engines. The boilers are of the Yarrow type built for 230 lbs. steam pressure.

MARINE ENGINEERING

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THAT the forward movement in American shipping is being recognized abroad by observant men is indicated by the words of Sir William H. White, Chief Constructor of the British Navy, in his presidential address before the British Institution of Mechanical Engineers in London recently. After referring to the nearly equal importance of the shipping interests of the United States and the United Kingdom at the outbreak of our Civil War, and the subsequent decline of our merchant marine, the distinguished naval architect said:

> Signs are not wanting, however, that our transatlantic cousins are not content with this (the present) relative standing, and we may anticipate a renewal of the old competition which is another reason for taking heed to our methods and machinery, and neglecting no source of economy in either building or working ships.

Sir William White evidently sees the handwriting on the wall, for as surely as the need for ships exists so surely will the rightful position of this country on the seas be restored. We, however, may, also, well "take heed to our methods and machinery," so as to hasten the day. There are numerous influences at work now which are for good in this direction, though many methods and a vast amount of machinery will have to be changed or replaced before America is mistress of the seas. These influences crop out here and there, often in unexpected ways. We know of two instances quite recently, as widely apart as the Atlantic and Pacific coasts, where precedent and tradition were departed from in the construction of vessels, and radical improvements in design and construction adopted in each case with unqualified success. In other important lines of manufacture, it has long since become impossible to continue a method or model just because the ancestors of some one interested used the same means or form to secure results. In bridge work and in locomotive building, two branches of the steel trade which have recently invaded the British field and created a sensation, not yet subsided, neither time nor material is used for any but sound engineering reasons. That some one in the remote past successfully attacked a problem that now again presents itself is very creditable to the deceased, but is no sound reason why similar methods should be employed now. It may be that the method then adopted cannot be improved upon, but the chances are almost certain that the advances in scientific knowledge, in materials, and in process of manufacture, will indicate a newer method. A walk through some of our older established shipbuilding plants will convince anyone familiar with modern methods that Sir William White's words are applicable to us. The unnecessary rehandling of material, the employment of slow moving and obsolete tools, the poor general arrangement of the plant, and the use of empirical and uncertain shop methods are too commonly observable.

AT a recent meeting of the Institute of Marine Engineers in London, a very sensible statement was made by a Mr. Halliday, which is applicable to marine affairs here or in fact those of any maritime country. A paper had been read giving an account of the performance of two merchant vessels at sea, and before discussion commenced Mr. Halliday suggested that the Society endeavor to have papers prepared by chief engineers of sea-going steamers, so that the Institute might come into possession of "detailed and reliable information" as to the actual working of marine engines at sea. He added that the paper just read might not be of great interest to the sea-going members, but to shore engineers it was a "matter of extreme interest and importance." It is a well-recognized fact that most of the published matter, of value, concerning marine engineering is from the point of view of con-

struction rather than operation. There are sufficient reasons, if not good ones, for this. Engineers as a rule are not owners, and, consequently, they are not at liberty to follow the promptings of their professional instincts. Secrecy is the policy adopted by the great majority of owners, be they of a corporate character or individuals. Usually this is an "ostrich" policy, for the real condition of affairs is very frequently plain enough to those who have experienced eyes and wits. A laughable example of this occurred not long ago in a port not a thousand miles from New York. A set of collapsed furnaces were removed from an ocean steamer, and in the dead of night carted from the yard in a covered wagon. While, however, the policy of secrecy does not prevent a knowledge of the truth among a few, it does keep from the many a proper record of experiences, which, discussed with engineering knowledge, would without doubt produce almost marvelous results. After all, design and construction are only a means to an end—the successful and profitable operation of a steam vessel fully adapted to the requirements of its trade. One of the most successful of the Clyde builders owed his success, in large part, to the frequent conferences which he held with sea-going engineers. When viewed from a strictly professional standpoint the present conditions are not entirely creditable to the marine interests. Making a comparison with the medical profession for example, the members of which are pledged in honor to the strictest secrecy regarding the personality of their patients, it will be seen that the physician and surgeon lives in a more truly professional atmosphere than the engineer. Without revealing the identity of his patients, he gives the most minute details of ailments and methods of treatment, and so scientific advancement knows no stop. If owners would only adopt a more liberal attitude in this respect they would be the greatest beneficiaries, for the whole trend of engineering progress is toward added profits for the owner.

IN ocean passenger service the growth of the "intermediate" type of steamer is very noticeable. This is especially so in the transatlantic trade where the number of such vessels now engaged in the service is considerable. Others are building, including some powerful ships, which, although perhaps not strictly answering to the description of intermediate, are more closely related to this type than to the record-breaking liner. In fact so successful has this type of vessel become, and so popular with ocean voyagers, that it is a question whether it will not eventually supersede the record-breaker for regular transatlantic service at least. The word just used—"successful"—gives the reason for the extensive adoption of the intermediate type. The operation of a line of steamships is a commercial undertaking, and thus compels the management to face either success or failure. Record-breaking ships and record-smashing trips are fine things in their way, but they do not, as a rule, produce dividends and that is what a steamship company is or should be organized for. Any other policy is sure failure. It is a significant fact that the older and better established lines are not at present in the record-breaking business,—a form of money spending which is now almost exclusively undertaken by the Germans. They no doubt have good reasons for the continuation of a record-breaking policy, but in their case there are enough slower ships to keep dividends up to high water mark, and the advertising feature of the policy is undoubtedly of great value to lines which are endeavoring to push to the front. The case is not without its parallel, which can be found in the railroad service of this country. Nowhere is greater attention given to the question of speed on railroads than here, and yet the number of sixty-mile-an-hour trains is extremely small in comparison to the number of moderately fast, luxuriously equipped passenger trains in daily operation. It is largely a question of profits, and the fast express has to be paid for by the way freight. Among the British and American transatlantic companies at least, the tremendous speed competition of a generation ago has given place to effort in the direction of better accommodations at moderate fares. The intermediate type of vessel has size sufficient to give most comfortable passenger accommodations, and steadiness at sea, and the necessary propelling machinery can be housed compactly and will run with a minimum of disturbing effects. Operating expenses are small, for the bulk of freight and number of passengers carried, as compared with the record-breakers and, of course, first cost, interest and depreciation charges are proportionately less. The transatlantic voyager is, during the summer season at least, a person of more or less leisure, and a day or two on the water more or less is, for him, well offset by the greater personal comfort and the more moderate fare on the intermediate ship.

CORRESPONDENCE DEPARTMENT.

[*Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced, if necessary to illustrate the subject, without cost to the writer.*

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Query Concerning Wireless Telegraphy.

Editor of Marine Engineering:

In your June issue, in an article on the "Marconi System of Wireless Telegraphy," the author, Mr. Poole, makes the following statement (see bottom of first column and top of second, page 27):

It is plain from the foregoing that the transmission of signals by these waves is limited by topographical and physical conditions to a certain degree; if an obstruction, such as a hill or the curvature of the earth, intervene between the points of communication, the vertical wires at each end must be of such a height as to afford an unobstructed path between a considerable length of their upper portions.

In a popular article in the June "McClure's," by Cleveland Moffett, speaking of the signalling between the Prince of Wales' yacht and the Osborne House, the statement is made:

On one occasion the yacht cruised so far west as to bring its receiver within the influence of the transmitter at the Needles, and here it was found possible to communicate successively with that station and Osborne, and this despite the fact that both stations were cut off from the yacht by considerable hills, one of those, Headon Hill, *rising 314 feet higher than the vertical wire on the Osborne.*

Again, Dr. Erskine-Murray, one of the company's chief electricians, is quoted as follows in answer to the question: "Then the earth's curvature makes no difference with your waves?"

It has made none up to twenty-five miles. which we have covered from a ship to shore; and in that distance the earth's dip amounts to about 500 feet. (I should think 400 feet J. W. C.) If the curvature counted against us, the messages would have passed some hundreds of feet over the receiving station; but nothing of the sort happened. So we feel reasonably confident that these Hertzian waves follow around smoothly as the earth curves.

Question: "And you can send messages through hills, can you not?"

Easily; we have done so repeatedly.

Mr. Marconi himself is quoted as saying:

It is likely, however that a limit for *directed* messages w'll be set by the curvation of the earth. This stops the one kind *but not the other.*

At the same time Dr. Erskine-Murray says that a vertical wire eighty feet long will send a message twenty miles. Of course, with a transmitting wire of that height and a receiving wire of similar height there would be afforded an "unobstructed path" between sixteen or seventeen feet "of their upper portions."

I perhaps owe your magazine, as well as Mr. Poole, an apology for seeming to question his statements on the strength of those in a popular article, but I should not do so if it were not for the fact that the latter are based on authenticated interviews.

Newport News, Va. J. W. Clary.

Reply.

Replying to Mr. Clary's letter above, the writer begs to say that Dr. Erskine-Murray's statement concerning the non-interference of the earth's curvature is a little misleading, though unintentionally so. No difficulty has been experienced in signaling 25 miles, because vertical conductors about 100 ft. high were used at each end. The length of a right line tangent to the earth's surface, from origin on the surface to a distant radial line, in statute miles, is approximately equal to,

$$1.4164\sqrt{h}$$

where h is the height of the radial line from the earth's surface to the tangential line. Consequently a line 25 miles long would just clear the earth's surface, theoretically, if drawn between the extremities of two masts 78 ft. high. The error consists in taking into consideration the height of only one vertical wire; the fact that there are two doubles the signaling distance. Hence we have:

$$2.8328\sqrt{h} = d$$

for a line between two mast-heads h feet high and just touching the earth's surface half way; and conversely,

$$\left(\frac{d}{2.8328}\right)^2 = \left(.353d\right)^2 = .1246d^2 = h,$$

h being the height in feet of each mast and d the intervening distance in miles. Any length of wire above this height may reasonably be considered active under average conditions.

The seeming discrepancy between this formula and Marconi's statement that the signaling distance varies with the square of the height is due to the fact that the above formula does not take into consideration the effect of the increased number of magnetic lines obtained by increasing the height of the vertical wire.

Referring to the account of an alleged successful transmission between the Prince of Wales' yacht and shore points with hills intervening, the absence of specific data concerning other vital conditions renders a deduction valueless. Moreover, popular articles are notorious for slovenly statements which seemingly justify unexpected conclusions, whereas accuracy of detail usually presents a totally different proposition. Unless Headon Hill is situated on one of those peculiar geological formations which insulate masses above them from the mass of the earth, it is inconceivable to the writer that signals could be transmitted through the hill.

That the electro-magnetic waves or oscillations follow the earth's curvature, the writer respectfully declines to believe until actual demonstration proves it true. The waves are similar to sound and light waves, which we know travel in straight lines except when reflected, and there is, thus far, no reason to believe that the magnetic waves differ in this respect, except in degree. They are not so susceptible to reflection and refraction. Unless an intervening mass is sheathed with some bright substance reflection does not occur, and when it does it is only partial. And if the intervening mass be common clay, Marconi waves impinging upon it will surely be arrested and resolved into definite alternating electric currents. Perhaps Headon Hill is pure silica or is set in a silica basin. Perhaps it was out of the path of transmission and did not intervene at all. Cecil P. Poole.

New York, June 20, 1899.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS.

BY DR. WILLIAM FREDERICK DURAND.

In the general sense, any receptacle in which steam is generated by the application of heat is a boiler. A boiler must, therefore, contain three fundamental features: a place for the fire, a place for the water, and a division or partition between them. The great variety of boilers arises from the different forms which these features take, and the different manner in which they are arranged. The keynote of the development of steam boilers from the earliest forms is contained in the word *subdivision;* subdivision of the hot gases and of the water so that no particle of either shall be very far from the partition or *heating surface,* as it is called. If in addition to this subdivision provision is made for a definite flow of the hot gas along one side of the heating surface and of the water along the other in the opposite

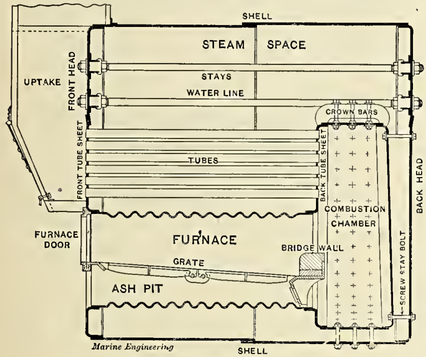


FIG. 1.—SCOTCH BOILER.

direction, the conditions for the most efficient transfer of the heat of the gas through the surface into the water will be fulfilled. In modern boilers the principle of subdivision has been carried to a high degree of development, but the conditions for proper circulation are but imperfectly fulfilled. The subdivision is obtained by the use of a large number of tubes or tubular elements surrounded by a shell or casing. The chief classification of boilers is made according to the relation of the water and hot gas to these tubular elements. If the gas is led through the inside and the water is on the outside, the arrangement is known as a *fire-tube* boiler. If, on the contrary, the gas is on the outside and the water circulates through the inside, the arrangement constitutes a *water-tube* boiler.

Fire-tube boilers may be divided into the *Return tubular* or *Scotch boiler,* the *Direct tubular* or *gunboat boiler,* the *Locomotive boiler,* the *Flue and return tubular* or *leg boiler,* and the *Flue boiler* as used on western river steamers. These are illustrated in Figs. 1-4.

Water-tube boilers are found in great variety, depending on the details of arangement of the tubes, and drums or headers of which they are composed. A few representative types are shown in Figs. 5-10. We will first give brief descriptions of the important features of these boilers, and then take up at a later point the subjects of their design and construction.

[1] THE SCOTCH BOILER.

In present practice, for marine purposes, the Scotch boiler is used more than any other one type, and, in fact, more than all other types combined. This boiler, as illustrated in Figs. 1 consists essentially of a cylindrical *shell* containing one or more cylindrical *furnaces,* usually corrugated circumferentially for strength, opening into *combustion chambers* at the back end, from which a large number of small *tubes* lead again to the front end or *head* of the boiler. The *grates* are placed at about the center of the height of the furnace, and the fire and hot gases occupy the upper part of the furnaces, the combustion chambers, and the inside of the tubes, while the water and steam fill all the remaining parts of the shell, the water level being usually some 6 in. to 8 in. above the highest part of the tubes or combustion chambers. The hot gases pass from the fire on the grate-bars into the combustion chamber, thence forward through the tubes and out through the *uptake* or *front-connection* to the *smoke-stack* or *funnel.* Several varieties of this boiler are in common use. Thus the number of furnaces may be one, two, three, or four. They may be fitted with separate combustion chambers, or there may be one combustion chamber for all furnaces, or, as is common with four furnaces, there may be two combustion chambers—one for the two furnaces on either side. Again, the boilers may be *single-end* or *double-end.* Fig. 1, is an example of the first. A double-end boiler consists of two sets of furnaces opening from either end of a shell of double length. It is evidently equivalent to a pair of single-end boilers placed back to back with the back heads removed and the shells joined. Such boilers may also have either separate combustion chambers for each end, or a common combustion chamber for both ends. The former arrangement is to be preferred, and becomes necessary where forced draft is used.

[2] DIRECT TUBULAR BOILER, GUNBOAT TYPE.

This boiler is rarely used except in war ship practice, where with low head room it has been occasionally employed. It consists of a shell with furnaces and combustion chamber somewhat as in the Scotch boiler, but the tubes, instead of returning to the front, lead on to the farther head. To this head is fitted a smoke-box or uptake leading to the funnel. In such cases the boiler for the same power is of smaller diameter and greater length than the Scotch type, and it is readily seen that the whole arrangement is simply a mode of exchanging diameter for length.

[3] DIRECT TUBULAR BOILER, LOCOMOTIVE TYPE.

The locomotive type of marine boiler as illustrated in Fig. 2 consists of a cylindrical shell extended to the front and modified in form with flat sides and bottom, and flat or rounded top. The furnace is of rectangular cross-section, and is surrounded by the shell at the front, leaving on the sides a narrow space known as the *water-leg* and sometimes a like space underneath known as the *water bottom.* The gases take the same general course as in the gunboat type, the chief difference in the two being in the form of the furnaces and in the ab-

sence of the combustion chamber in the locomotive type.

[4] The Flue and Return Tubular or Leg Boiler.

In this boiler, as illustrated in Fig. 3, the hot gases pass from the furnace through large tubes or *flues,* as they are termed, to a combustion chamber at the farther end. They then return to the front through small tubes,

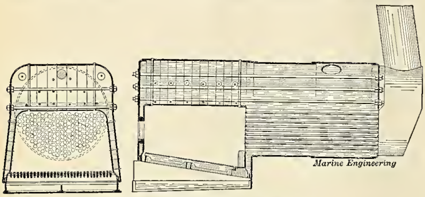


Fig. 2—Locomotive type boiler.

and are led by an appropriate uptake to the funnel. The furnace is of rectangular cross-section, and the front end of the boiler is modified on the sides and bottom to correspond to this form, as in the locomotive type. Water legs are also formed in the same way on the

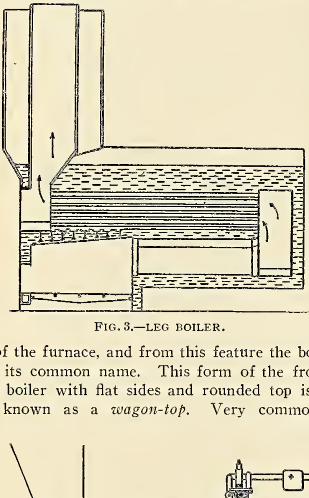


Fig. 3.—Leg boiler.

sides of the furnace, and from this feature the boiler receives its common name. This form of the front end of the boiler with flat sides and rounded top is sometimes known as a *wagon-top.* Very commonly, as shown in Fig. 3, an attachment to the shell, known as a *steam chimney,* surrounds the lower part of the funnel, the office of which is to subject the steam to the drying and superheating effects of the gases on their way through the funnel. Boilers of this type have been used to a considerable extent on tug and river boats.

[5] The Flue Boiler

In Western River practical use is commonly made of the return flue boiler as illustrated in Fig. 4. This boiler is eternally fired. The flames and hot gases pass back along the outside of the boiler to a back connection and then enter the flues and return through them to the front, and thence to the uptake and funnel. Boilers of the locomotive type, or tubular fire-box boilers as they are often called, are also used to a considerable extent in western river practice.

[6] Water Tube Boilers.

Turning now to this type, a brief description will be given of the leading features, which may be combined in the greatest possible variety, thus giving the vast number of forms of such boilers on the market at the present time. To aid in the description a few typical forms of such boilers are shown in Fig. 5.

Most boilers of this type have one or more cylindrical drums or chambers on top and one or more similar drums below, the two sets of drums being connected by sets of tubes. The feed usually enters first the upper drum, frequently passing on its way through a coil heater in the base of the stack or top of the boiler. It then flows down certain of the tubes to the lower drums. If these tubes are of extra large size and specially intended for down flow, the boiler is said to have special *down flow* or *down cast tubes* or pipes, as shown in Figs. 6, 8, 9. In some cases such tubes are omitted, and the feed must descend through part of the small inner tubes. In any case, after finding its way to the lower drum it enters the *up flow* or steam forming tubes, which are surrounded by the hot gases coming from the furnace below them. During the passage of the water upward it is partly converted into steam, and the mixture issues from the upper end of the tubes into the upper drum. There the steam is separated and led to the engine, while the water joins that already in this drum, and thus begins another round. In some cases the upper ends of the steam forming or delivery tubes are below the level of the water in the upper drum, and they are then said to be *drowned* or *wet.* In other cases they are above the water level and are said to be *dry.* In still other forms they enter at about the middle of the drum or about the water level, and may be *wet* or *dry* as the level varies. See Figs. 6 and 11 Water tube boilers are often divided into two general classes: *large tube* and *small tube* boilers. In the former they are

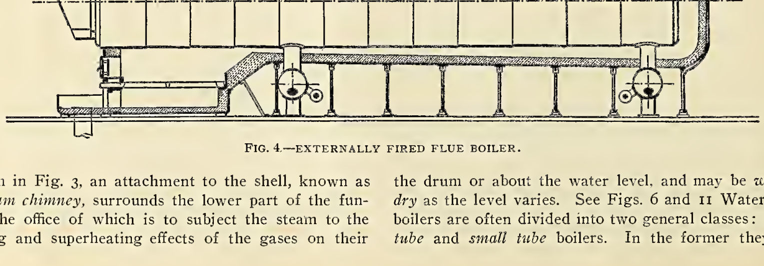


Fig. 4.—Externally fired flue boiler.

usually 3 or 4 or even 5 in. dia., while in the latter they are usually from 1 1-4 to 1 1-2 or 2 in. dia.

Again, the tubular elements may be made up in a great variety of forms. In some they are straight, as in Figs. 6, 8, 9, 10; in others, curved, as in Figs. 5 and 7. In small tube boilers they are very commonly curved or bent, while in the large tube types they are straight. Also in some types the elements are continuous between

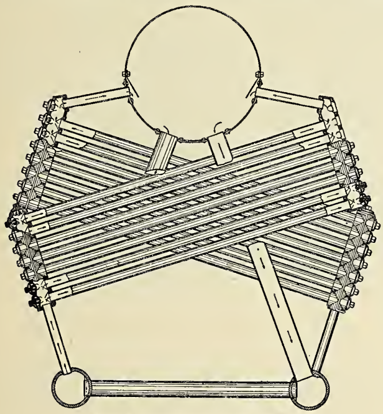


FIG. 6.—STRAIGHT TUBE TYPE.

drums or headers as in Figs. 5 and 7, while in others, as in Fig. 10, they are made up of lengths or of different parts with screwed joints, elbows, returns, junction boxes, etc. In some they are expanded into the shells of the drums; in others screwed. In some all joints are carefully protected from the direct action of the flame; in others screwed joints are freely exposed to the flame. In some the general direction of the tubes is nearly horizontal; in others nearly vertical, and in others bent or curved in various forms. In some types, as illustrated in Fig. 9, the lower drums are omitted, or consist merely of the lower portions of the tubes and *headers*, or members to which the tubes are connected. In all cases the grate lies below the tubes and frequently

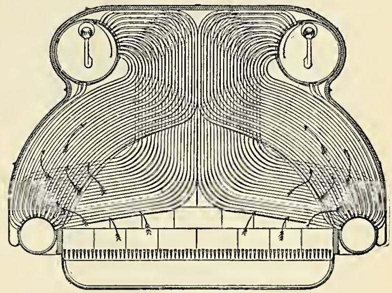


FIG. 5.—CURVED TUBE TYPE.

between the lower drums, as shown in Figs. 5 and 7; while the whole is surrounded by a casing intended to prevent, so far as possible, the loss of heat by radiation.

[7] RELATIVE ADVANTAGES OF DIFFERENT TYPES OF BOILER.

For large ships under ordinary conditions and where the extremes of lightness or of speed on a given displacement have not to be attained, the Scotch boiler

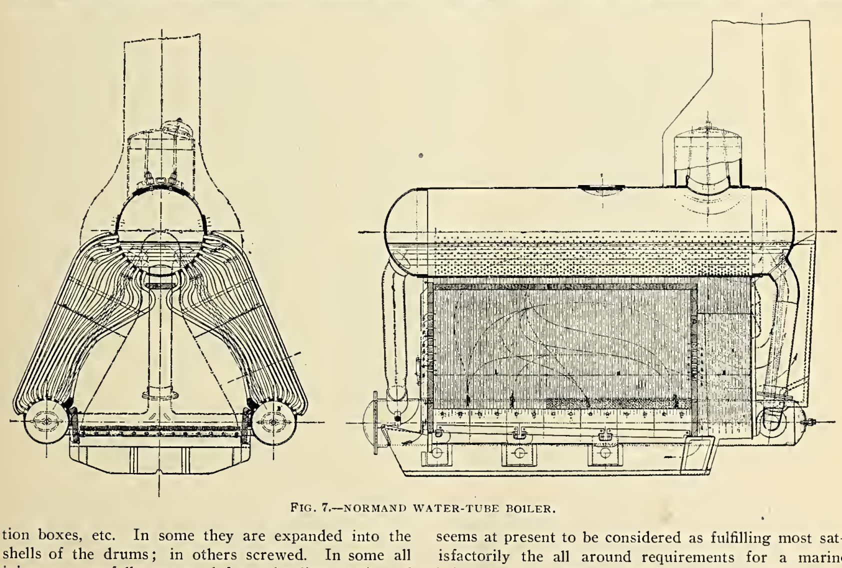


FIG. 7.—NORMAND WATER-TUBE BOILER.

seems at present to be considered as fulfilling most satisfactorily the all around requirements for a marine boiler, and in consequence it is found almost universally

in the mercantile deep sea marine, as well as on the Great Lakes and to a large extent on inland craft of all descriptions, except those of small size. It is also used extensively in naval practice on all craft except those of the torpedo-boat type, though the use of water-tube boilers is at the present time extending quite rapidly into this field, where their special features become of marked value.

For tugboats, river steamers, and a variety of small craft, the various types of direct fire-tube and flue boilers have been much used. These boilers are more readily adapted to a variety of demands regarding size, form and arrangement, and in small sizes are perhaps more cheaply built than Scotch boilers. In many cases, however, the preference for boilers of this type has doubtless depended on local and special conditions quite independently of their relative value from the engineering standpoint.

For fast yachts, launches, all craft of the torpedo-boat type, and in fact in all cases where the highest speed is to be attained on the least weight, the water-tube boiler has become a necessity, and in one or another of its many forms is universally employed. The weight of Scotch boilers without water per square foot of heating surface is usually from about 25 to 30 lbs.; of water-tube boilers of the lighter types from 12 to 20 lbs. The weight of the contained water per square foot of heating surface is usually from 12 to 15 lbs. for Scotch boilers, and from say 1.5 to 3 lbs. for water-tube boilers. It results that Scotch boilers with water will weigh from, say, 35 to 50 lbs. per square foot of heating surface, while water-tube boilers will similarly weigh from 13.5 to 23 lbs. These figures are not to be considered as giving absolute limits, but simply as representative values for average types. It should be noted, however, that a square foot of heating surface in a Scotch boiler seems to be somewhat more efficient than in a water-tube boiler. It is difficult to estimate the difference numerically, but other conditions being equal, it would probably be safe to give to the water-tube boiler additional heating surface to the extent of from ten to twenty per cent. On the other hand, it must be remembered that water-tube boilers can stand forcing to a much higher degree than fire-tube boilers. With the latter supplying steam to triple expansion engines the ratio of heating surface to I. H. P. can hardly be reduced below 2, while with the former this ratio has been reduced in many cases to less than one and one-half, and, as reported in certain extreme cases, to between one-half and one. Water-tube boilers have the further advantage that they are more readily constructed for the higher and higher steam pressures which modern practice is continually demanding. With water-tube boilers due to the construction and to the smaller amount of contained water, there is also less danger from disastrous explosion. With water-tube boilers steam may be raised much more quickly than with fire-tube boilers; from one-quarter to one-half hour is sufficient with the former, while from three to four hours should be taken with the latter.

Water-tube boilers are also much more portable than fire-tube. In many forms spare parts or even the whole boiler may be shipped in elements or sections across country by rail or to foreign ports by ship transport, put on board the steamer for which they are intended, and erected in place without difficulty.

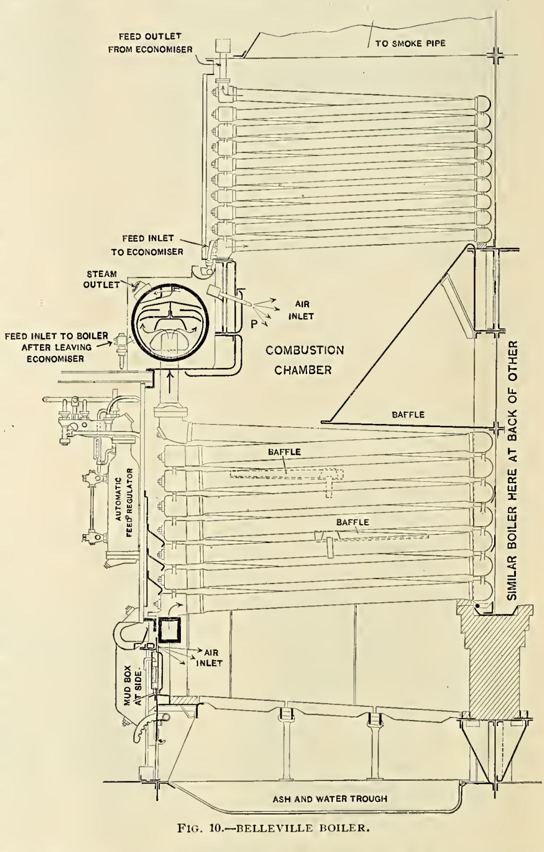


FIG. 10.—BELLEVILLE BOILER.

On the other hand, the water-tube boiler imperatively requires fresh water feed. Under modern conditions this should be provided no matter what the type of boiler in use, but if in emergency salt water must be used, the fire-tube boiler will receive the lesser injury.

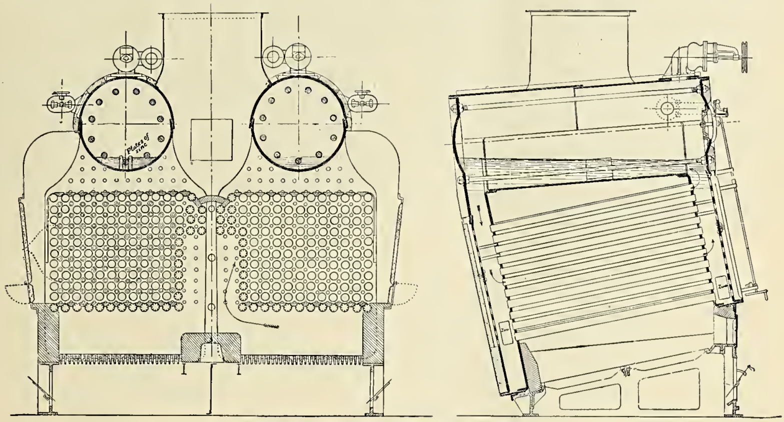


FIG. 9.—D'ALLEST WATER TUBE BOILER.

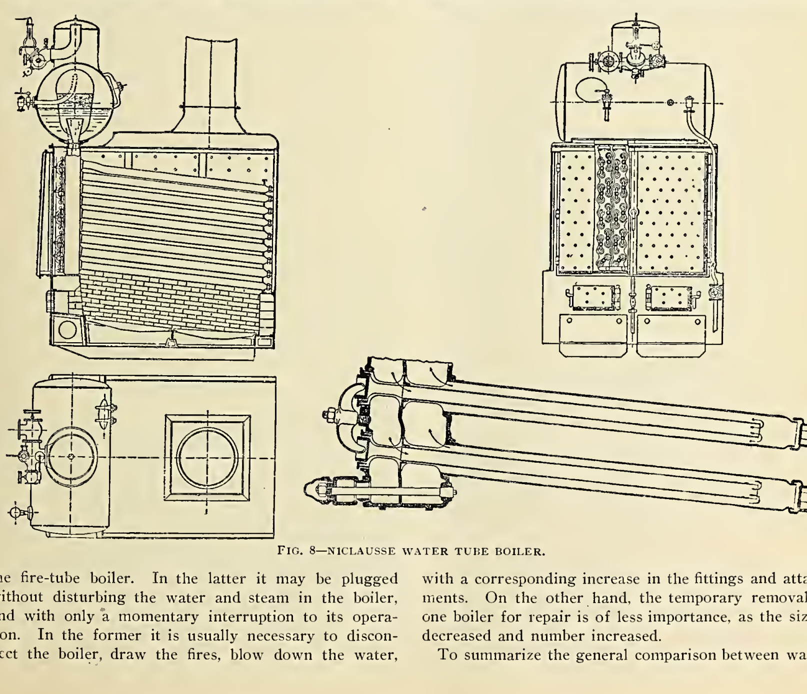


FIG. 8—NICLAUSSE WATER TUBE BOILER.

Again, from the small amount of water contained as a stock upon which to draw, the water-tube boiler requires a more uniform feed than the fire-tube boiler, and is generally more sensitive to variations in the conditions under which it works. Again, the rupture of a tube is a more serious matter in the water-tube than in the fire-tube boiler. In the latter it may be plugged without disturbing the water and steam in the boiler, and with only a momentary interruption to its operation. In the former it is usually necessary to disconnect the boiler, draw the fires, blow down the water, and plug or insert a new tube. Water-tube boilers are also not readily made in large sizes or units. Scotch boilers may be made in 2,000 horse power units or even larger, while half of this or less is about the maximum for the water-tube boiler. An outfit of the latter for large power requires therefore a large number of boilers with a corresponding increase in the fittings and attachments. On the other hand, the temporary removal of one boiler for repair is of less importance, as the size is decreased and number increased.

To summarize the general comparison between water-

tube and fire-tube boilers, the former have relative advantages in the following chief points: Weight, ability of feed, greater difficulty in dealing with leaky tubes, safety from disastrous explosion, and quickness of raising steam. On the other hand they have relative disadvantages in these points: A more rigid restriction of the feed to fresh water, the necessity of greater regularity of feed, greater difficulty in dealing with leaky tubes, and general sensitiveness to variation in the conditions of use, to which may be added the present feeling of uncertainty as to their durability and efficiency under the conditions prevailing on deep water voyages.

THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS—VIII.

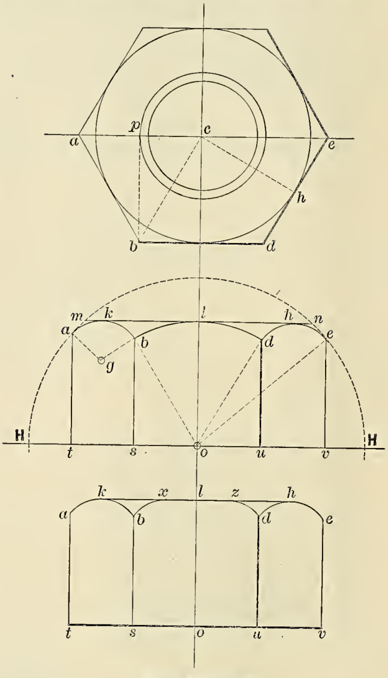
BY PROF. C. W. MAC CORD.

The idea is to some extent prevalent that in a mechanical drawing the representation of every detail must be accurately *constructed*, as though the object were to prove the draughtsman's knowledge of the laws of projection. This is by no means always the case—the object of a working plan is to show the workman what to make and how to make it; and usually it is desirable that the drawing should be made in as short a time as may be. In view of this latter consideration, we shall now proceed to illustrate some ready methods of representing certain details, by which much time may be saved, without at all impairing the practical correctness of the drawing.

The first example is that of a hexagonal nut, or bolt-head, which is shown as accurately constructed in Fig. 30. The axis of the hexagonal prism being vertical, the upper end of the nut is shown as finished off by turning it to the form of a spherical surface, which is very commonly done. Let H H represent a plane through *o*, the center of the sphere, perpendicular to the axis; then all the edges of the prism will pierce the sphere at the same distance from H H, so that the points *a*, *b*, *d*, *e*, all lie in one horizontal line.

The three visible faces of the prism will cut the sphere in three equal arcs of circles; of which the front one, *b l d*, being parallel to the paper, will in the front view be seen in its true form and size, its radius being *o b*. The other two, *a k b*, *d h e*, would strictly appear as arcs of ellipses; but these are of such small extent that approximating circular arcs may be used instead; it being noted that their middle points, *k h*, must lie on a horizontal line through *l*, to which line they are tangent, the radius, *a y*, may readily be found by trial and error. If the nut be cut off by a plane through *l*, as it often is, and is usually represented, the complete outline will also include the curvilinear triangles *a m k*, *h n e*; the portions *a m*, *e n*, being arcs of the circumference of the sphere. This has been set forth at length, because it may occasionally be worth while to represent the nut with all this precision of detail, as, for instance, in an elaborate "show drawing," or in the case of a nut of unusually large size. And it is to be noted that the height, *o l*, is equal to *o t*, half the "long diameter" of the hexagon (a very common proportion); also, that *s* bisects *o t*—because, as seen in the top view, the hexagon is made up of equilateral triangles similar to *a b c*, so that *b p*, perpendicular to *a c*, bisects *a c* at *p*, which corresponds to *s* in the front view. If, then, the long diameter, *v t*, be assigned, the points *t*, *s*, *o*, *u*, *v*, can be marked off at one setting of the scale, and *o l* at another; then the arc, *l b*, determines the heights of the points *a*, *b*, *d*, *e*, and *o e* is the radius of the arcs *e n*, *a m*.

Now, bolts used as fastenings, as for cylinder covers, valve-chest covers, etc., are seldom met with of a diameter greater than one inch and a quarter, except in very massive machinery; but a considerable number of that size or less have often to be shown on a single sheet, and that, too, upon a reduced scale. The small triangles, such as *a m k* of Fig. 30, would, then, be hardly perceptible unless drawn with most painful care; and



FIGS. 30 AND 31.

in such cases the short-hand method of Fig. 31 should be adopted. The little triangles are omitted, and instead of the single arc *b l d*, we draw two arcs, *b*, *x*, *z*, *d*, with the same radius as that of the arc *a k b*. This single radius, then, suffices for drawing all the curves of all the nuts of the same size, instead of using three radii for each nut, as in Fig. 30. Thus, it is shown that the corners are to be rounded off, which is all that the working drawing need indicate; and the saving in time is very great, which is a most important practical item.

And in drawing the hexagonal nut another point is to be considered—the proportion between its "long

diameter" and the diameter of its bolt. In the "standard" systems this proportion varies with the diameter of the bolt, and beginners are often afflicted with the idea that they are bound to conform to the tables; in consulting which they waste much valuable time. This is quite needless, for the workman looks only at the diameter of the *bolt;* if this be specified, as it always should be, the corresponding standard nut will be used, whether the drawing does or does not show it of the exact size. A very simple and ready rule, then, is this: For 1 1-4 in. bolts or less, make the long diameter of the nut twice that of the bolt, and for larger ones, 1 3-4 times; the height of the nut to be half its long diameter. And it may be well to recollect that the heights *t a*, *s b*, etc., of the points *a*, *b*, *d*, *e*, will then be practically 7-8 of the height of the nut.

In Fig. 32 two pieces are shown, fastened together by two bolts; the one on the left being a tap-bolt, the other a standing bolt, or stud. In the former the thread must extend a little above the face *a b*, its termination being made conspicuous by a dotted line; in the latter the thread should terminate abruptly at the surface, as shown. The thread is represented merely by the V's, as in making a section; the at-

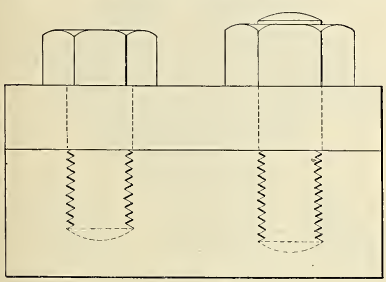


Fig. 32.

tempt to dot in the top and bottoms would result simply in a confusing mass of dots. In drawing the V's the triangles should not be used; having first drawn lightly in pencil two guiding lines, the V's should be drawn freehand in ink at once, using a fine steel writing pen. Nor need the V's be measured—with a little practice all the accuracy needed in a working drawing can be secured by the eye; the movement is simple, a light up stroke being followed by a heavy down stroke, as nearly at 60° to each other as may be, and as regular as possible; in order to avoid a tendency to round off the angles the pen should be lifted off the paper at each stroke.

A bolt is very seldom of such size as to call for the accurate construction of the helical curves of the threads; but sometimes it is desirable to make a drawing like that shown in Fig. 33. Here the V's are carefully laid out with the triangles, but "full sharp" and not flattened at top and bottom; the crests and roots are then drawn as right lines—the former heavier than the latter, because the crests cast shadows.

But even this amount of labor need hardly ever be expended in a working drawing; for bolts of small and medium sizes the mode of representation illustrated in Fig. 34 answers all purposes. Here no attempt is made at drawing the V's—the outer line of the bolt is drawn *in full*, and the threads are indicated by drawing a long and a short line alternately, the former being the

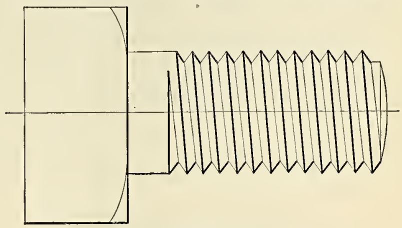


Fig. 33.

thicker, since it represents the crest, which casts a shadow, as above mentioned. The length of the short lines should be limited by two guiding lines drawn in pencil, as was the depth of the *V s* in Fig. 32; and their inclination may be readily determined, as in the diagram at the right; *m*, *m*, here represent the guiding lines just mentioned, and *b a c* is the section of a thread; then, since the root on one side is opposite the crest on the other, *c* is projected "square across" to *d*, and *a d* is the required inclination. The triangle being set by this, the lines may be spaced by the eye, just as in sectioning. Be it understood that this is a purely conventional *indication*, and does not pretend to be a *drawing*, of the screw; nevertheless, it will, unless quite large, look more like one than a correct drawing can be persuaded to, without wasting a prodigious amount of time and labor.

The preceding relates more to instrumental drawing than to sketching; what follows is equally applicable to both. Fig. 35 illustrates an important rule, to which there are very few exceptions, and that is, that *the continuity of masses of metal in sectional drawings should not be interrupted for the purpose of showing fastenings.* The figure represents a portion of a cylinder with its flange and cover; and the leading idea is to show at a glance the thickness and the breadth of

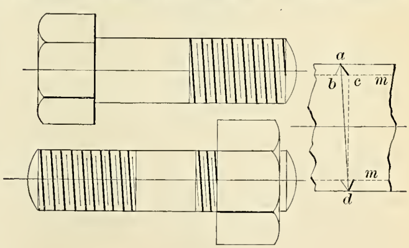


Fig. 34.

each of the flanges forming the joint. The cylinder and the cover must, of course, be fastened together, and the bolts are made for that purpose; but they should not be made unduly prominent.

A very common and a very faulty method of showing the same thing is given in Fig. 36; and those who adopt it urge in defence that it is the only correct way, since the bolt lies in the plane of the section. But the effect is very much as if the bolt were the most important item, and the cylinder and cover had been made chiefly for the purpose of using it. Still worse, two little portions of the flanges are thus isolated, like islands off a headland; so that the main idea is neither as clearly nor as forcibly expressed as in Fig. 35, while the labor of making the drawing is greater.

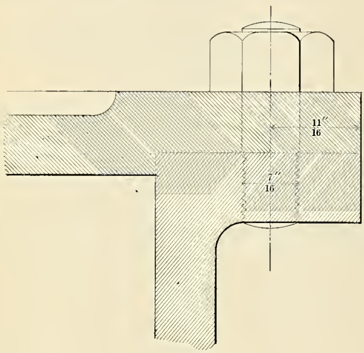


FIG. 35.

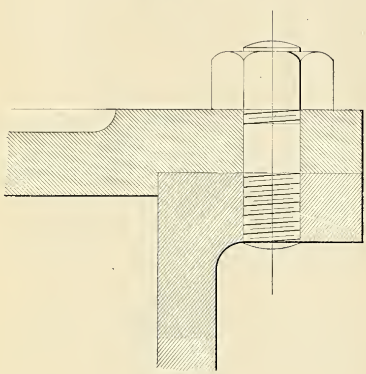


FIG. 36.

Now, whether the bolt lies in the plane of the section or not, it is certain that no misunderstanding can arise from using the first method, because the number and location of the bolts will be shown in the end view, and cannot be shown without it.

The same principle is illustrated in Fig. 37, which shows one arrangement of a double-riveted joint between two wrought-iron plates. This should be drawn as in A; if the rivets are drawn in full, as in B, each sheet is cut into three detached parts in the sectional view, so that the extent of the lap, which is of prime importance, is not made to catch the eye at once, as it should, but requires a little study and mental arithmetic for its full realization. The relative proportions of the principal parts, in short, should be made as conspicuous as possible; and in the representation of such joints there is nothing which could make them *less* conspicuous than to cut them up into little pieces, as in Fig. 36, and in B of Fig. 37. Reverting now to Fig. 35, it is to be noted that the diameter of the bolt is figured in, and also the distance of its center line from the edge of the flange, which should always be done, even in full-size drawings. This side view, again, shows whether the nut is to be square or hexagonal; consequently, in the end view it is only necessary to draw the bolt-holes for the purpose of showing their number and arrangement. It is a common and a melancholy thing to see all the *nuts* carefully drawn in the end view, and with equal care projected back to the side view and drawn in there. All of which is no less than a wicked waste of time; no one can tell from the side view how the bolts are spaced, and no one cares how they would look in that view. So again, the side view of one nut shows that it is in this case hexagonal, and

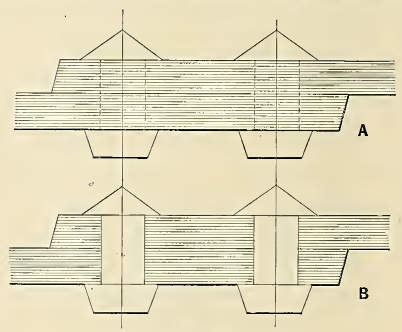


FIG. 37.

nothing is gained by drawing the end view of it and its companions. This general principle, then, should be clearly grasped and tenaciously retained—that *each view should be made to tell all that it can with certainty, but should concain nothing not worth showing.*

In the new monthly publication *Ueberall* the increasing interest which the German people are manifesting in marine affairs is fitly expressed. A very striking design has been adopted for the cover representing "Germania" pointing towards the sea, and beneath the words "Unsere Zukunft liegt auf dem Wasser" (Our future depends upon the sea). The new publication is the organ of the German Naval Society, founded April 30, 1898, under the Patronage of Prince Henry of Prussia, and its object is to further the interest of German Naval affairs. The articles are written in popular style, though technically correct, and there is a splendid profusion of half-tone illustrations. The periodical is edited by Commander Herman Gercke, I.G.N., and is published by E. S. Mitler & Son, Kochstrasse, Berlin, Germany.

ENGINEERS' DICTIONARY—XIX.

Furnace Bridge. See *Bridge-wall.*

Furnace Crown. See *Crown-sheet.*

Furnace Door —A door in the furnace front serving to open up the furnace to the fire-room Through this door the coal is thrown by the shovel, and the cleaning and working of the fire are carried on as may be required. The furnace door is usually of double thickness of metal with air space between, the two plates being provided with a certain number of small holes for the admission of air above the grate.

Furnace Front —A framework fitted to the front of the furnace and carrying the furnace door or doors.

Fusible Plug —A plug of fusible metal, usually Banca tin, placed in the highest part of the heating surface of a fire tube boiler. So long as the plug is covered with water its temperature will not rise to the melting point, and it will remain in place. Should

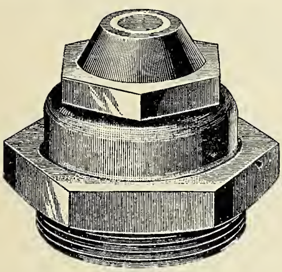


Fig. 75.

the water fall below, uncovering the plug to steam on one side and fire on the other, its temperature will rise and it will melt, giving notice of the low water by the escape of the jet of steam. In Fig. 75 is shown a composition plug fitted for screwing into the heating surface at any convenient point, and having a core of fusible metal extending through it as shown.

Gab-Lever —In the ordinary types of beam engine the valves are worked from a rock-shaft, extending across the front of the engine. This rock-shaft has an arm carrying a pin to which the eccentric rod hook is connected. This arm is known as the gab-lever.

Gallows Frame —The frame work which supports the beam of a beam-engine. See under *Engine*, Fig. 59.

Gasket —Sheet packing cut to shape and used to make a tight joint in such places as manhole covers, valve-chests, condenser bonnets and pipe flanges.

Gauge —A general name for instruments used for measuring, usually pressures or the height of water in a boiler, feed tank or other closed chamber. Thus *steam-gauge* for measuring the pressure of the steam, *water-gauge* for showing the level of water in the boiler, etc. See also *Air Gauge.*

Gauge Cock —A cock attached to the chamber of a boiler water-gauge. The gauge cocks are usually three to five in number, arranged with vertical intervals of a few inches. They serve to show independently of the gauge glass the approximate level of the water in the boiler. In some cases they are attached directly to the boiler or chamber containing the water.

Gauge Glass —A glass tube forming part of a water gauge, the latter being connected at the bottom to the lower part of the boiler or other chamber containing water, and at the top to the upper part. The water will then stand at the same level in both tube and boiler, thus showing to the eye the height of water as desired.

Gauge-Pipe —A pipe connecting a gauge with the boiler or other chamber, within which the pressure or height of water is to be measured.

Gate Valve —A valve for closing or regulating the opening in a pipe. The moving part of the valve consists of a slide moved by a screw back and forth across

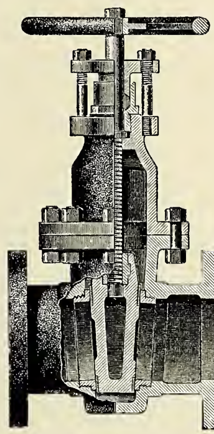


Fig. 76.

the opening of the pipe. See Fig. 76, in which the valve is closed. It will be noticed that when the valve is wide open there is an unobstructed passage, for the gas or liquid, through the valve.

Generator —A common name for a dynamo—a machine for generating an electric current. The term *generator* is also frequently used in referring to boilers of the water-tube type.

Grease-Cock —A cock placed in the shell of a boiler near the water line, and through which the grease and scum which collects near the surface of the water may be blown into a connecting pipe and thence overboard. This arrangement of cock or valve and pipe is more commonly known as the *surface blow.*

Grease Cup —A cup containing grease for lubrication, and from which it feeds to the place where needed, either as it is forced by a piston or plunger urged by a spring, or as it is melted by the heating of the part requiring lubrication.

Grommet —Packing consisting usually of a few turns of cotton-wicking or similar material, placed under the head of a bolt to prevent leakage when the bolt is drawn into place.

QUERIES AND ANSWERS.

Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Owing to a typographical error the formula for finding the diameter of boat davits was incompletely given in the May issue. The correct formula reads:

$$d = 2.2\sqrt[3]{\frac{AW}{P}}$$

EDITOR.

Q.—Please publish a rule for setting slide valves in duplex donkey pump. NORTH CAROLINA.

A.—Steam pumps may be divided into two classes—first, those in which the steam is used expansively, and second, those in which the steam follows full stroke in the steam cylinder.

The first variety is usually equipped with a crank-shaft and fly-wheel, which are driven either with a slotted link or connecting rods. As the pressure in the water cylinder is constant throughout the stroke, the momentum imparted to the fly-wheel assists the steam piston after cut-off has taken place in the steam cylinder, with the resultant diminishing of pressure in the same. This style of pump is often used in city water pumping plants and for other purposes where large quantities of liquid are pumped against a comparatively constant pressure, and where economy of steam is important. For smaller sizes of pumps this style has been abandoned, owing to the excessive weight of the fly-wheel, large space and foundation required, and the inability to control the capacity within large limits. The steam valves of fly-wheel pumps are driven by an eccentric on the crankshaft, and in all respects are the same as the valves on an ordinary steam engine.

The second class of pumps may be subdivided into two classes:

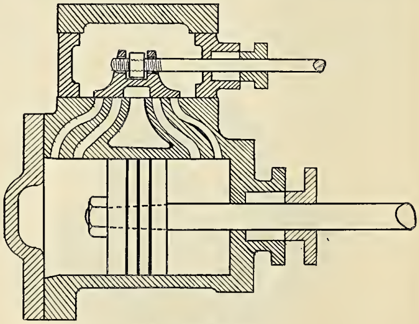
First. The so-called single cylinder pump, in which the steam valve is indirectly actuated by its own piston rod, and, Second, the duplex type, consisting of two steam cylinders, in which the valves are each actuated by the piston rod of their adjoining cylinders. The duplex type must not be confounded with the frequent twin arrangement of single cylinder pumps where each cylinder works entirely independent of the other. In both of these types the steam follows full stroke in the cylinder, and therefore it is evident that the valves do not require either steam or exhaust lap, and in practice only a small amount is given—just sufficient to make them steam tight. The valve mechanism is so designed that the valve is shifted at the end of each stroke so as to uncover one steam port and exhaust through the other.

In a single cylinder pump this motion could not be obtained directly from the piston rod, as the piston is momentarily at rest when it is time to shift the valve. To produce the desired effect an auxiliary valve is adopted, working directly from the piston rod, and which is usually of the ordinary D form or equivalent. Directly attached to the main valve is a long piston working in a cylinder in the main valve chest. When the steam piston approaches the end of its stroke the auxiliary piston is mechanically shifted by gear from the piston rod, admitting steam to one side of the auxiliary piston, containing the main valve, causing the latter to shift. This explains in a general way the action of the so-called single pump, although there are many modifications of the type and directions for adjusting and setting of valves for one particular make of pump would not apply to others.

The duplex pump requires neither auxiliary valve nor auxiliary piston, for when one piston is momentarily at rest at the end of its stroke its valve is shifted by the motion of its neighbor, which has not quite finished its stroke.

As stated in the foregoing, the proper motion to be imparted to a steam valve is to shift it when the piston reaches the end of its stroke. To accomplish this there is a certain amount of lost motion to be given to the valve. This can be produced by means of a tappet, worked from the piston rod and sliding between adjustable collars on the valve stem, giving the valve a push at the end of each stroke. Another and more common way is to drive the valve rods uniformly from the crossheads by means of links and levers, the lost motion being effected by adjustable nuts where the valve stems pass through and are attached to the valves. In some of the most modern duplex pumps these adjustable nuts and also the tappet collars have been discarded, and in place of them the valve is cast with a yoke on top containing a square block, which is attached to the valve stem. This block drives the valve and fits loosely between the jaws of the yoke, according to the amount of lost motion required. The exact amount of lost motion can only be determined by trial. Too little lost motion will reduce the stroke of the pistons, and too much of it will increase the stroke to the extent that the steam pistons will strike the cylinder ends, thus covering the steam ports and causing the pistons to stick fast, as the steam cannot get behind them.

In adjusting the valves of a duplex pump it is necessary that they throw equidistant from the center of the seat, and that



STEAM END OF PUMP.

both valves are set exactly the same, as the false setting of one valve will make the adjoining cylinder work erraticly, as well as its own.

Large pumps are usually fitted with two steam ports at each end. The outer steam ports enter the cylinder directly at the ends and the inner ports a certain distance from the ends. The valve works the same as for the single ported type, except that the outer ports are for steam entrance only and the inner ports only for leading exhaust steam from the cylinder to the regular exhaust port of the valve. When the steam piston arrives near the end of its stroke it covers the exhausting port, and as the steam left in the end of the cylinder has no outlet, it will act as a buffer on the piston, thus preventing it from striking the ends. So-called cushioning valves are fitted to each end of the cylinder, controlling openings between the double ports, whereby the amount of cushioning can be easily increased or diminished. In the accompanying sketch the working parts of the steam end of a pump are shown.

The twelfth annual edition of Beeson's Marine Directory, for the season of navigation, 1899, is received. This standard book has been thoroughly revised and brought down to date. It contains a great variety of information for the use of Owners, Agents, Manufacturers, and Supply men, including: List of American steam vessels on the Lakes, Vessel owners, Record of Engines and Boilers, Miscellaneous matters of interest, Soo Canal statistics, Iron Ore Output, Descriptions of American Lake Ports, Insurance Ratings, Classified directory of trades, and a great variety of minor matters. The book is well bound and printed, and is a very valuable work of reference. It is published by Harvey C. Beeson, Royal Insurance Building, Chicago. Price, $5.

MARINE ENGINEERING.

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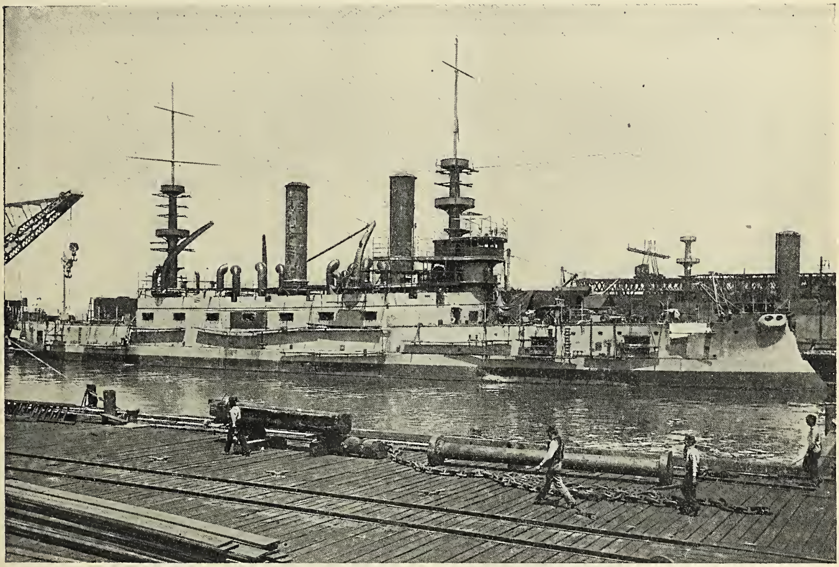
U. S. BATTLESHIP KEARSARGE NEARING COMPLETION AT NEWPORT NEWS SHIPYARD.

The appearance of a battleship when nearing completion at the builders is well illustrated in the photograph of the U. S. S. *Kearsarge*, taken recently at Newport News and here reproduced. The construction of this fine vessel together with her sister ship the *Kentucky* was authorized by act of Congress of March 2, 1895, and the contract for her construction was signed January 2, 1896. Both the *Kearsarge* and the *Kentucky* were launched on the same day, March 24, 1898. The *Kearsarge* is a vessel of 11,525 tons displacement and is of these dimensions: length, 368 ft.; beam, 72 1-2 in. and draught, 23 ft. 6 in. She is fitted with twin screws driven by triple expansion engines of 10,000 I. H. P., designed to give a sea speed, with forced draft, of 16 knots. Her boilers are five in number, three double ended and two single ended, of the Scotch type. They are 15 ft. 6 1-2 in. outside dia. and about 10 ft. and 20 ft. long respectively. The shells are of 1 7-16 in. steel plate, and the working pressure is 180 lbs. Forced draft on the closed fire room system is fitted. There are two smoke pipes, as will be noticed in the photograph, spaced widely apart in a fore and aft direction. Her design calls for an armament of four 12-in. and four 8-in. breech loaders carried in pairs in double turrets, the small guns being superimposed on the larger. In addition there will be fourteen 5-in. rapid fire guns in the central battery, and the smaller guns will include twenty 6-pdr. and six 1-pdr. rapid fire guns, four Colt automatic guns and two 3-in. field guns. Four torpedo tubes will be fitted. The armor will be Harveyized steel, ranging in thickness from 17 in. in the turrets downward to 9 in., according to the location.



U. S. S. KEARSARGE LYING AT THE BUILDERS' WHARF-ONLY 13-IN. TURRETS IN PLACE.

New Ships for International Navigation Company.

Particulars of the six new steamships under construction for the International Navigation Company are of interest. Four of these vessels are building at Clydebank, Scotland—two for the Red Star Line and two for the American Line. The remaining two are to be built by William Cramp & Sons, Philadelphia.

The vessels to be built by Cramps will be sister ships to the vessels under construction at Clydebank for the Red Star Line.

The Red Star Line vessels under construction at Clydebank will be named *Vaderland* and *Zeeland,* and will be of the following dimensions: Length, 560 ft.; beam, 60 ft.; depth, 42 ft.; measurement, about 12,000 tons, and displacement, 20,000 tons. They will be fitted with twin-screws and bilge keels, and will have accommodations for 300 saloon, 250 intermediate and 750 steerage passengers. The two classes of cabin passengers will be carried amidships in a bridge deck-house, and there will be a limited number of suites provided for saloon passengers. The main dining saloon will be large enough to accommodate all the first-class passengers at one sitting, and the usual comforts and conveniences, such as library, smoking rooms and lavatories, will be provided. The state-rooms will be large, and special attention will be given to their ventilation, so that even in rough weather, when all the doors are closed, there will be an abundance of fresh air in the living quarters.

The second cabin accommodations will be unusually comfortable, in that they will be situated in the deck-house, and most of the rooms will be really deck cabins. For the accommodation of this class of passengers there will be a large amount of promenade deck space and comfortable smoking rooms, and a social hall in addition to the dining saloon. The steerage accommodations will be strictly up to date. These passengers will be berthed in two, four and six berth rooms, well lighted and ventilated, with extensive lavatories and bath accommodations, and for their recreation there will be well sheltered deck space and a large social hall.

These vessels will be fitted with a moderate amount of power, so that they will be able to make the trip from New York to Antwerp, about 3,300 nautical miles, in eight days, which gives a steaming rate of about 17 knots.

The two vessels building at Clydebank for the American Line will be named *Merion* and *Haverford,* and they will be put on the Philadelphia-Liverpool route. They will be of the following dimensions: Length, 530 ft.; beam, 59 ft.; depth, 39 ft.; measurement, about 10,000 tons. These vessels will be of the intermediate type, with a large cargo carrying capacity and a sea speed of 13 knots.

Following the custom of the Philadelphia service of the American Line, there will be accommodations for only one class of cabin passengers—saloon. To the number of 130 they will be provided for in the deck-house amidships. The accommodations will be strictly modern in every respect, though undoubtedly the fares will be rather lower than are charged on the fast ships. There will be accommodations for about 800 steerage passengers. The steamships now on this service are the *Belgenland,* 3,692 gross tons, built at Barrow, and the *Pennland,* 3,760 gross tons, built at Glasgow.

MARINE GROWTHS—AN EFFECTIVE ARGUMENT FOR THE BUILDING OF DRY DOCKS.

BY COMMANDER H. WEBSTER, U. S. N.

The experience of those who go to sea in ships is that many parts of the ocean are filled with the eggs and embryos of numberless types of animal and vegetable life, and it is against the injury done by these so-called "marine growths" that the ingenuity and chemistry of shipbuilders and ship owners are in constant activity.

Tropical waters are teeming with animal and vegetable life, and this is especially true of those coasts where the tides are small and the sea currents feeble and infrequent.

Without going into the scientific names of the various growths, it is enough to say that the teredo, or ship borer, the barnacle, sponges, oysters, coral formations and grasses form an aggregation ever ready to pounce upon and adhere to any solid presented.

Many of these formations are classed as on the debatable line between the animal and the vegetable kingdoms, some of the growths in Honolulu being described as a "shell-less oyster without any meat."

It is a common error to assume that a coppered bottom does not become foul, for after a longer or shorter period the copper surface becomes covered with a film of a neutral nature, and upon this film all the marine growths noted adhere and flourish about as luxuriantly as where no copper exists.

The reason for this can be readily understood when the process whereby copper acts when submerged is understood. Copper in sea water is feebly acted on by the free sulphuric acid held in solution, and a minute quantity of copper sulphate is formed. From this arises the faint green tint noticed on the bottom of a coppered ship. This copper sulphate is poisonous to all marine growths save a few of very low order, so that the germs, which in innumerable multitudes are constantly seeking a resting place, are either killed or sickened, and so the surface remains clean, or nearly so. Besides this poisonous action of the copper sulphate it has also an exfoliating action, and by the motion of the waves, assisted by the speed of the ship, thin flakes or films are continually becoming detached from the sheets of copper, carrying with them, of course, any adherent animal or vegetable matter.

But in course of time this formation of copper sulphate decreases in quantity, and the surfaces slowly but surely become coated with a black substance, formed partly from the copper and partly due to the gradual accumulation of life forms not affected by the films of copper sulphate. As soon as this takes place and the surfaces become innocuous, marine growths, both animal and vegetable, will flourish as readily and luxuriantly as upon any other submerged surface, and the coppered ship needs docking and cleaning as much as her painted bottomed sister.

This process in the decline of protective power is exceedingly slow, however, and whereas the painted bottom becomes foul in a few months, sometimes weeks, the coppered bottom will remain clean and serviceable for three or four years, depending, as in the other case, upon the waters visited.

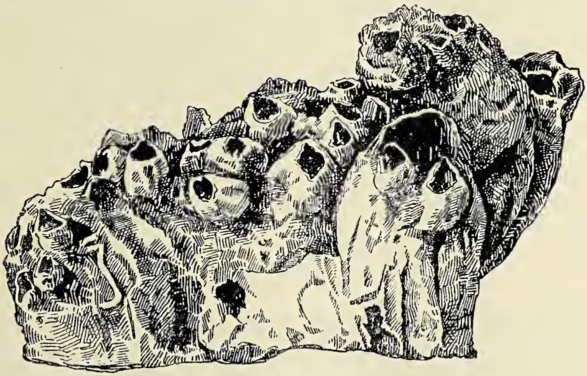
The methods employed for the removal of barnacles and grass are not various, consisting in going from salt water to fresh, in scraping the bottom by divers and by scraping the bottom while the ship is in dry dock.

The first method is only efficacious in the removal of vegetable growths, for while the animal life is speedily killed by the fresh water, the shells and envelopes with which these animals are protected remain, giving a firm foundation for new growths as soon as the ship resumes her cruise at sea.

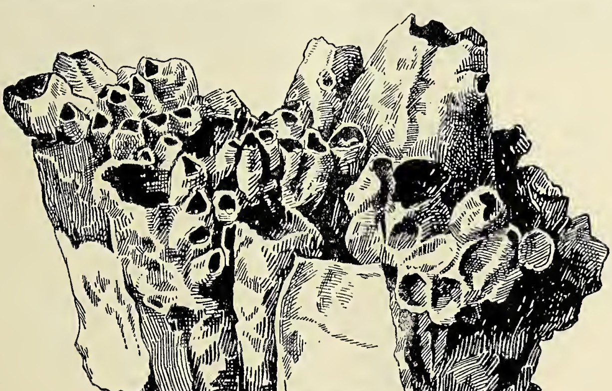
So far from the sea-growths being injurious to the bottom of a metal ship, they afford not a little protection to the steel or iron, and where the bottom is thickly coated with barnacles no injury is likely from the usual influences, and if the ship is lightly grounded the envelope of marine growths has been known to have been a sensible protection from injury.

From the foregoing it will be understood how complicated and difficult is the problem with which the shipbuilder in confronted.

First, he must protect the ship's bottom; next, he must not cover it with a substance to which marine life can adhere without injury, for then the ship's speed and efficiency begins to suffer as soon as the voyage commences. Neither must he apply a substance which, while detrimental to life be also injurious to the ship's material. And so the puzzle grows, until the ingenuity of the chemist, the metallurgist and the sailor have evolved the various paints, coatings and protectors with which the navigator is tempted to defy the elements, animate and inanimate, found in every sea.



BARNACLES REMOVED FROM SHIP'S BOTTOM—FULL SIZE.



BARNACLES REMOVED FROM SHIP'S BOTTOM—FULL SIZE.

Every variety of paint tried thus far fails to protect, though some retard the evil more than others; but the inevitable arrives, and the difference is one of time alone and is not very great. Other conditions being equal, the warmer the water the more rapid the fouling.

As regards iron, the product of its corrosion in sea

water adheres strongly to its metallic base and seldom, or never, falls off, and whatever marine growths attach themselves to it remain and grow, receiving ever increasing accretions until the mass, if not removed, increases to inches in thickness, the sea moss thickly filling up the interstices. The same result happens to the painted surface if the paint remains unbroken, and, as indicated above, continues a long time when protected by the covering of marine animals and plants already described.

In the solution of the problem, therefore, it is necessary to make a choice of two evils, one of which is of the most pressing nature, while the other evil is so far removed from the first that it must be regarded as almost no evil at all.

The method which has been found by experience to offer almost complete immunity from fouling to either iron or steel ships is that of sheathing the ship's bottom with wood and then coppering it.

The custom of sheathing is of very ancient date, and is found in vogue in China and Japan at the present time, having been brought down from time immemorial. The bottoms of those curious craft known to us as junks are constructed of wood, but their bottoms are not protected by a metal covering. Instead of which they are coated with pitch which, in turn, is sheathed over with thin boards or planking as a protection for the submerged portion of the hull. This sheathing is renewed at intervals, with the result that one of these junks has been known to remain in seaworthy condition for a century.

The process of sheathing a modern warship is one of the most difficult tasks set for the Naval Constructor. The metal bottom of the ship to be sheathed must be so prepared that it is completely insulated from the copper with which the wooden sheathing is covered, and this wood planking must be so secured to the ship that no reasonable amount of strain shall dislodge or rupture the continuity of the sheathing.

As a matter of fact, in the British Navy, the space remaining between the wooden envelope and the iron or steel bottom of the ship is filled with liquid red lead forced in by powerful pumps until a complete film of this substance is interposed between the wood and the metal.

Notwithstanding the care and expense this process entails, incidents occur when it becomes inefficient and the ship is in even a worse condition than if no sheathing had been attempted.

The British corvette *Calliope* is a case in point. During the hurricane at Samoa, in March, 1889, this ship, in common with those of the United States and Germany, was buffeted by wind and sea almost to destruction, and it was found that the wooden sheathing had become so much strained by the incidents of the hurricane that before necessary repairs could be made the underwater part of the hull was so corroded and injured that a large expense was necessary to retain the ship in the active list.

Although cleaning a ship's bottom can only be properly done in a dry dock, and must be attended to as often as once in six months, the operation of docking is an expensive one, as well as dangerous.

In government docks the sole expense is that of labor to prepare the dock for use and take the ship in and out. For a vessel of 4,000 tons or under, this amounts to about $400; but to this sum must be added the scraping and painting, say a thousand dollars more, or a total of not far from $1,400, and this, too, must be incurred on an average twice a year.

It is something quite different when a private dock is employed. A few years ago a French ironclad was docked, scraped and painted at San Francisco, and the bill amounted to $15,000.

One of the many puzzling things connected with "those who go down to the sea in ships," is that the larger the ship the higher are the charges, notwithstanding the fact that in the given dock the amount of water to be pumped out is less as the ship's displacement increases.

As soon as the ship enters the dock the responsibility of the dockmaster begins, and as the water begins to fall and the ship takes the blocks the process of scraping the bottom as it emerges from the water begins. By the time the water is out of the dock the ship's bottom is clean, and the mass of marine life lying in the dock almost surpasses belief.

During the cruise of the U. S. S. *Alert* on the China station the ship was docked and cleaned at Hong-Kong, and not less than thirteen tons of barnacles, coral and vegetable marine growth were removed.

Barnacles four inches long, sea grasses six feet in length, pieces of sponge six inches in diameter, coral growths covering square feet in area, are a few of the singular objects found on a ship's bottom whenever she is docked for cleaning and painting.

A barnacle has been not inaptly described by Huxley as "a crustacean fixed by its head and kicking the food into its mouth with its legs." The technical name of the barnacle is *Lepas anatifera*. The Teredo, *Teredo navalis*, or borer, is a worm-shaped, grayish-white animal, noted for its destructive habits in boring into submerged timber. It has very long united siphons, and thus looks like a worm, and varies in length from a few inches to three feet. These marine growths are of almost universal distribution, extending from 74 north latitude to Cape Horn. Marine animal life is largely a matter of temperature, the warmer the waters the more rapid the growth.

The accompanying photograph shows the growth on the bottom of the U. S. S. *Bennington*, while on the Pacific coast of Guatemala for but sixty-three days. Its companion illustrates the appearance of the bottom after being scraped and painted at the Mare Island Navy Yard in 1894.

The difference in friction between a copper bottom and a painted iron skin has an important bearing on the question of speed, and the result of experiment gives the following figures:

Surface.	Resistance Coefficient.
Clean copper	.007
Smooth paint on iron or steel hull	.010
Iron or steel skin	.014

From which it appears that the friction of an iron or steel skin is twice that of a smooth copper bottom.

W. H. White, the well-known British Naval Constructor, writes as follows on this branch of the subject:

A third deduction is the great increase (of friction) which results from a very slight difference in the apparent roughness of the surface.

Frictional resistance is the most important element of the total resistance of most ships and in well-formed ships moving at moderate speed it constitutes nearly the whole of the resistance.

As a general result, the resistance of a well-painted iron or steel bottom will average, for an exposure of three months to sea-water, an increase of 50 per cent, involving a loss of about one-seventh of the speed. For example, a vessel that makes fourteen knots per hour with clean bottom will average only twelve knots during the three months.

If at the commencement of the three months the resistance be taken as one, then at the end of the three months it will be represented by two, and the loss of speed at the end of the three months will be about one-fourth; that is to say, the fourteen knots will have fallen to ten knots.

B. F. Isherwood, late Engineer-in-Chief, U. S. N., has the following to say in this connection:

The only method known whereby this disastrous loss of speed can be prevented is to sheathe the bottom of the iron vessel to a certain height above water with wood, and to copper the sheathing; and this method must be adopted for naval cruisers.

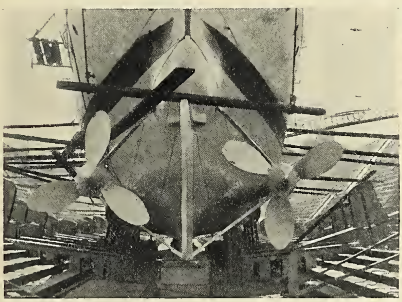
Of course, the final argument in the question makes its weight felt in the coal bunker, for if the speed of the ship is reduced by a foul bottom the quantity of coal required to steam a stated distance will vary in inverse ratio.

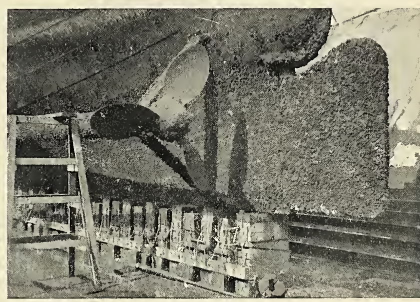
A notable illustration of this occurred last year in the inability of the Spanish fleet under Admiral Cervera to steam at anything like its normal speed owing to the condition of the bottoms of the vessels composing that fleet.

The fact that a vessel may be almost constantly under way seems to have but little influence on the underwater conditions, these marine growths being so minute in their earlier stages that the friction of the water passing the moving ship has no appreciable effect on the "spat" so freely distributed by nature.

Tropical waters, especially, teem with animal and vegetable life, and the conditions here are such that at no time are their activities modified. Once a barnacle, or, indeed, any form of marine life, effects a lodgment on a ship's bottom nothing short of actual mechanical force will dislodge it. In spite of speed, in spite of change of temperature, in spite of everything except scraping, the tiny speck of life grows, strengthens and adds to its resistance, until it affords protection for other forms of obstruction, and so the process goes on until in the language of the sailor "the ship can't get out of her own way," and docking becomes the only path away from disaster.

It may be asked why a ship cannot be cleaned more or less thoroughly while still afloat and on her station, either by mechanical devices or with divers. As a matter of fact, this is quite practicable, but as has been said, these marine growths cling with such tenacity that in removing them the film of paint to which they adhere is also removed in the operation, and the naked metal of the ship becomes exposed to the corrosive action of the sea water, and the last state of that ship is likely to be worse than the first. Consequently a stringent prohibition exists against cleaning a ship's bottom except while in dock, when the removed paint can be at once replaced.





STERN VIEW OF WAR VESSEL BEFORE AND AFTER SCRAPING IN DOCK.

It has been said that the measure of a nation's naval strength is gauged by the number of docks it can control, for thereby its efficiency and supremacy are maintained in time of war, and the security enjoyed by that country whose ships are sure of docking facilities all over the world forms one of the strongest arguments for this form of governmental expenditure.

The distribution of the dry docks of the world and the countries controlling them or owning them is as follows, and is approximately correct:

Great Britain, of course, stands at the head of the list with no less than 343 docks, of which it absolutely owns forty-two. The United States follows with a total of but sixty, six being of government ownership. France owns thirty-two, the other maritime and naval nations following in this order: Italy, eight; Germany, eight; Spain, seven; Sweden, six; Austria, Belgium, Denmark, Holland, Japan, Chili and Brazil with two each.

The foregoing list is probably not strictly accurate, it being compiled from information gathered several years since, but it is sufficiently correct for purposes of comparison.

The old adage that "it is never too late to mend" finds its application, in this connection, in the disposition shown by the last Congress to increase the number of government dry docks to something approaching the necessities of our navy, and a good beginning is thus being made toward the formation and maintenance of a fleet which shall be regarded as in some sort an exponent of the commanding position the nation is taking in the world by sheer force of wealth and population.

The events of the year just drawing to a close have emphasized in a manner understood of all the reasons for a navy, and the practical-minded American feels that whatever we need we must have, and that of the best. And having, in many respects, the best ships in the world, it is imperative that they be maintained at the high standard of efficiency for which they have always been noted.

The record made by the sheathed (composite) ships of our navy since their completion should be sufficient to convince the most skeptical of the wisdom of adding whatever of expense is entailed by the system for the sake of the improved efficiency of the ships, as units, and of the navy as a whole.

But while we are building dry docks let us not drop back into the "penny wise but pound foolish" ideas of the advocates of wooden docks, whose life is measured by that of the weeds and grass which flourish on the decay of their fabric.

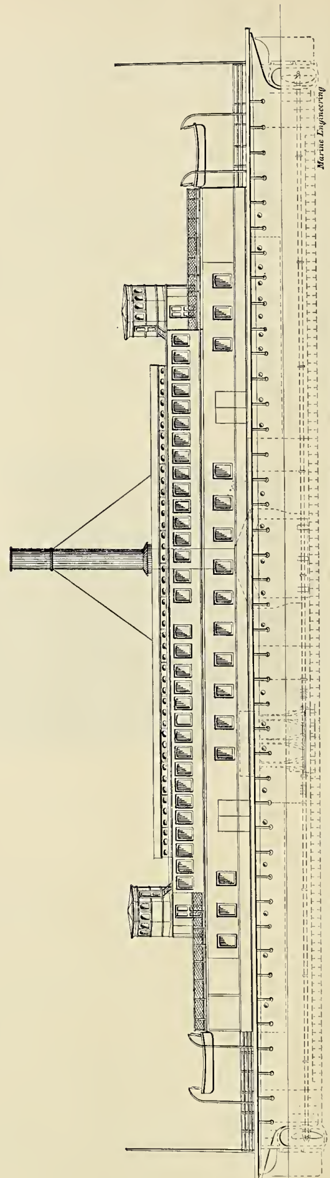
Therefore, sheathed ships, stone dry docks, coaling stations, should be regarded as the component parts of an harmonious whole whereby the phrase "United States Navy" should stand for all that is defensive, offensive, protective and efficient.

PROPELLER FERRYBOAT BERKELEY IN SERVICE IN SAN FRANCISCO BAY.

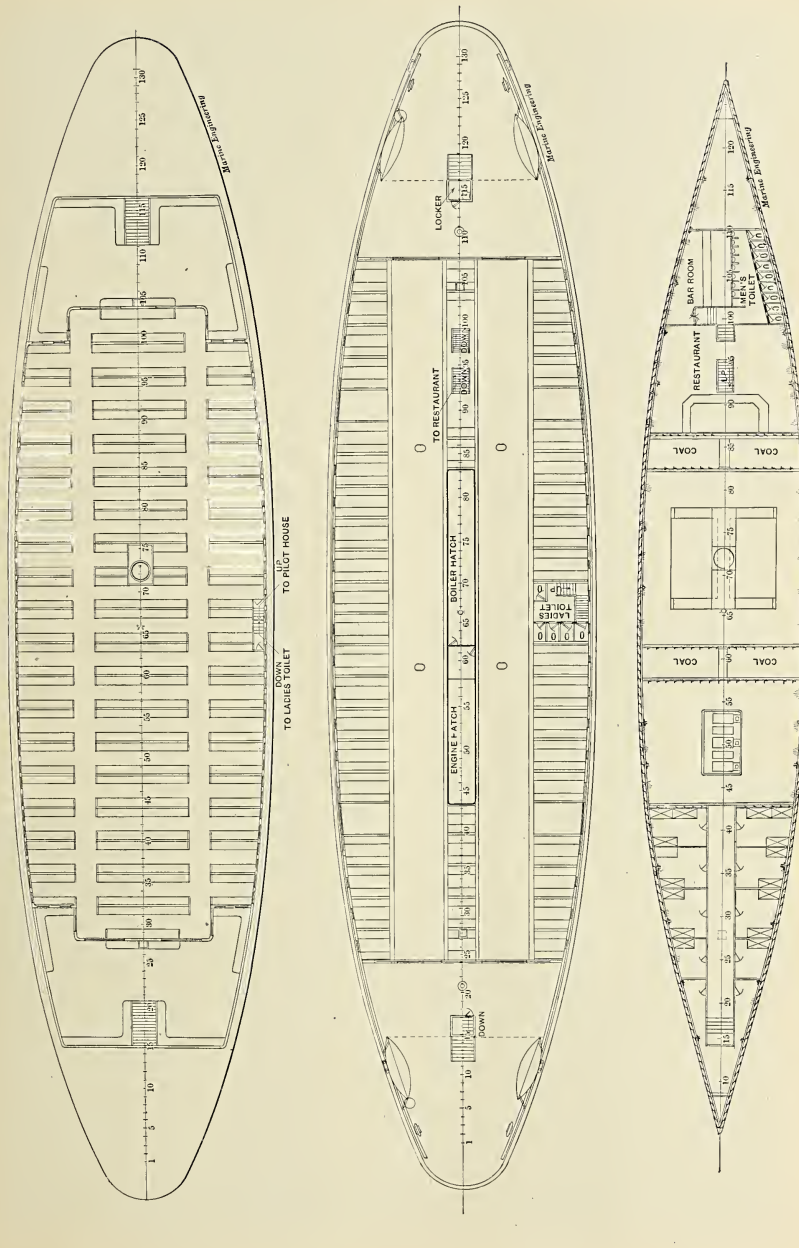
Photographs of the ferryboat *Berkeley* show the first *propeller* ferryboat put in service on the waters of San Francisco Bay. As is well known the ferry service between San Francisco and Oakland, California, has been for a number of years unexcelled the world over in point of size and appointment of the ferryboats. The vessels used have hitherto all been paddle steamers, fitted with side wheels with radial floats. When the construction of the *Berkeley* was decided upon the manner of propulsion was very carefully discussed, and after many consultations it was decided to build a boat with one set of engines and one line of shafting, running from end to end, with a single propeller at each end, instead of twin screws, such as are used in the ferry service on the North river, New York.

The *Berkeley* has a steel hull, measuring 289 ft. over all, 260 ft. on the water line, 40 ft. moulded beam, 64 ft. beam over the guards, 16 ft. 6 in. depth, and a tonnage of 1,245 tons.

The keel was laid on January 25, 1898; the boat was launched on October 18, 1898, and completed November 6, 1898. The christening ceremony was very pleasing on account of the interest taken in the vessel by the good people of the borough of Berkeley, who presented the vessel with a suit of flags, in honor of the boat being named for their town. The boat was launched from the yard of the Union Iron Works by



PROFILE OF DOUBLE SCREW FERRYBOAT BERKELEY, IN SERVICE BETWEEN SAN FRANCISCO AND OAKLAND, CAL.



PLANS OF THE DOUBLE SCREW FERRYBOAT BERKELEY BUILT AND ENGINED BY THE UNION IRON WORKS, SAN FRANCISCO, CAL.

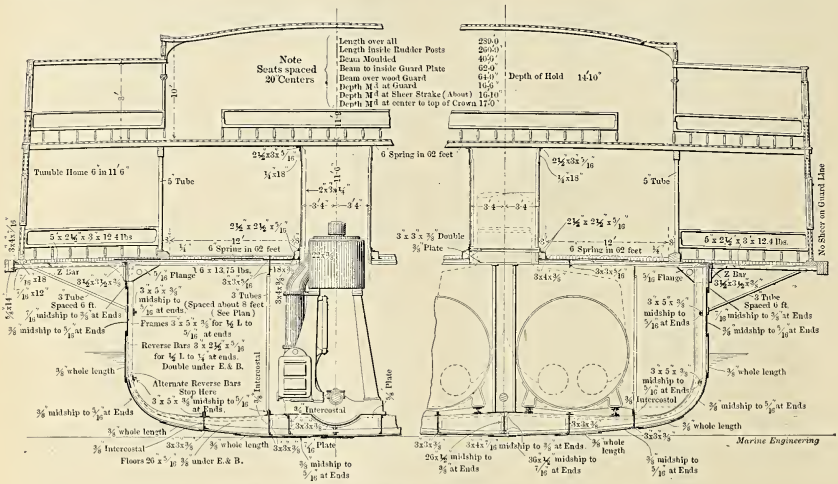
Miss Marion Huntington, of San Francisco, and christened by Miss Ruby Richards, of Berkeley, while the flags were raised to the breeze by the children of prominent residents of Berkeley.

The *Berkeley* has a total seating capacity for 1,750 passengers. The framing for the seats is all made of teak wood, while the seats themselves are made of perforated wood. The upper cabin extends to the almost extreme ends of the upper deck, completely enclosed in plain glass; and running around the top of the cabin is a narrow strip of handsome ornamental colored glass. The cabin is free from all obstructions, with the exception of the small casing, which allows the smoke pipe to pass up through the top of the house, and a sufficient number of small stanchions to prevent vibration of the arched roof.

One other subject that attracts a good deal of attention and is a novelty as applied to ferryboats is the means of ventilation in this cabin. The columns at the sides and at the ends of the seats are all made of gas pipe, with a register at the upper end in the ornamental work, while the lower end connects with the air trunks made of steel. They pass underneath the upper deck and thus serve the double purpose of air trunks and supports to the upper deck. Below in the engine-room there is placed a ventilating fan, run by an independent compound engine, which takes its suction from the outside, delivering fresh air throughout the boat, the supply being controlled by the registers. In the winter time, in wet weather, or when it is cold, this fresh air is passed over a coil of steam pipe, and heated to any degree that may be required, before it is discharged into the cabin. This means of ventilation although creating some doubt as to its efficiency when adopted, has proved by service that it was not a mistake, and has met with general approbation.

The pilot houses are at either end, in the usual manner. The vessel is provided with steam steering gear, of the three cylinder engine type, as made by the Union Iron Works, having an engine on the main deck, directly beneath each pilot house, and connected with the rudders at the opposite ends of the vessel.

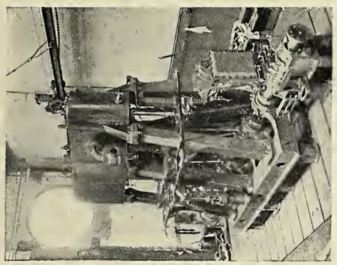
The stairways from the main deck to the upper deck are somewhat different from most ferryboats, having been placed in the middle of the deck, one at either end, facing the ends of the vessel. Each stairway is built of teak wood, with brass fittings, has ample width for a crowd, and altogether has rather an ornamental appearance. The passengers, of course, are landed both from the upper and lower decks at the same time, and are admitted to the boat in the same manner, so that the least possible amount of time is consumed in taking on and discharging the passengers.

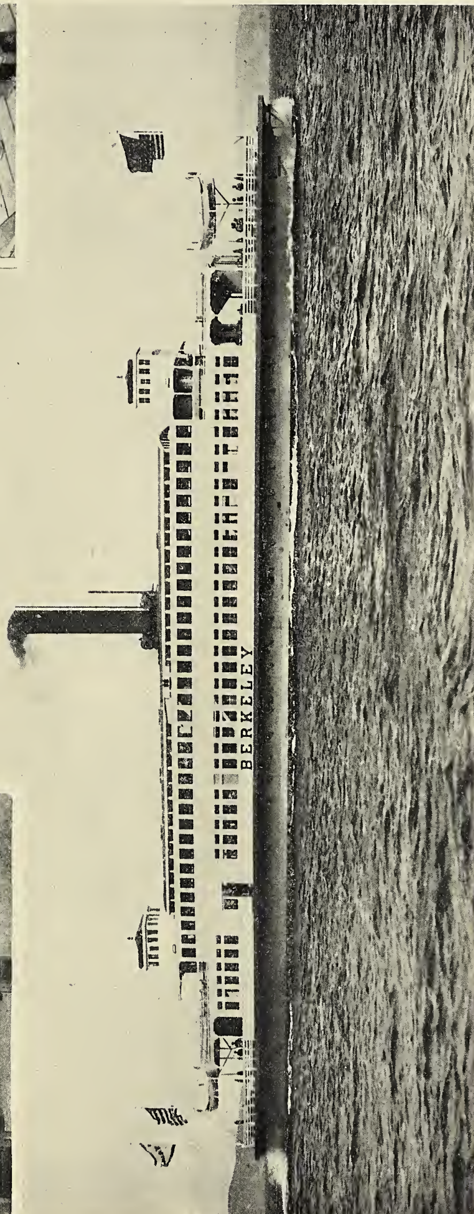


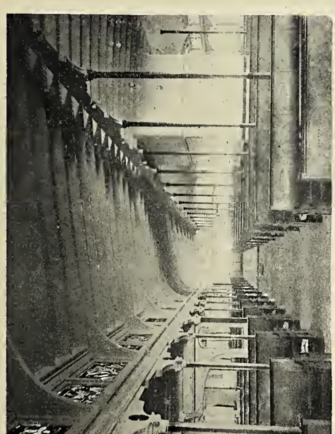
CROSS SECTIONS OF DOUBLE SCREW FERRYBOAT BERKELEY.

The main deck is provided with large seating capacity, and the trunk for the engine and smoke stack occupies the minimum amount of space, because of the cylinders of the engine coming beneath the deck. Under the main deck there have been placed the bar room, toilets and restaurant at one end, and living quarters for the crew at the other end. These arrangements, while they met with a good deal of criticism before the boat was put into service, have since become a favorite arrangement with the traveling public. This is true, however, of all departures along new lines.

The boilers of the *Berkeley* are two in number, 10 ft. 10 in. dia., 19 ft. long, double ended, with two 36 in. corrugated furnaces at each end, carrying a pressure of 165 pounds of steam. There are 304 plain and 136 stay tubes 2 1-2 in. by 7 ft. long. The engine is triple expansion, with cylinders 22 in., 34 in., and 56 in. by 36







VIEW OF FERRYBOAT BERKELEY UNDER STEAM—UPPER DECK ACCOMODATION AND ENGINE.

in. stroke, and at 125 revolutions develops 1,450 indicated horse power. The two propellers are cast solid of bronze, 8 ft. dia. by 14 ft. pitch, with four blades and an expanded area of 30 6-10 sq. ft. The engine, as shown in the photograph, is provided with a steam reversing gear, box guides for the cross heads and a horseshoe thrust-bearing at each end. The condenser is cast in with the back columns; the piston rods are all provided with metallic packing; the air pump is independent of the engine, and the circulating pump is a centrifugal pump.

During the first weeks of her trial, a rather annoying circumstance occurred. At the season of the year when she was put into service, the bay was filled with young spawn. These little fish were so small that they were taken in with the circulating water and almost blocked the ends of the condenser tubes. The trouble was overcome by reducing the size of the holes in the strainer of the suction to the circulating pump.

The boilers are provided with two independent sets of blowers, designed and built by the Union Iron Works, to furnish air to the Howden system of forced draft for the boilers. The double set of blowers have been provided because of the hard service on this route, so that at no time could the boat be crippled for lack of draft.

She is also provided with two independent electric plants; one a compound verticle engine, with cylinders 7 1-2 in. and 13 1-2 in. by 6 in. stroke, and a 400 light 16-candle-power machine. The other is an auxiliary lighting plant of 100 lights, placed for day service, or at any time when only a few lights are required.

The *Berkeley* is provided with four water-tight bulkheads, reaching from her keel to the main deck, without an opening in any one of them. This was done with a view to guaranteeing the safety of the vessel, as supposed water tight doors are almost invariably found open when wanted. There is a complete system for fire, with hose and reels, and life preservers are stored beneath the seats, perfectly accessible to even the smallest child.

The vessel was designed, built and engined by the Union Iron Works, and since she was put into service has given entire satisfaction.

S. Y. Josephine.—The new steam yacht *Josephine*, building at the yard of Neafie & Levy, Philadelphia, Pa., will soon be ready for sea. The dimensions of this vessel are: Length, 216 ft.; beam, 30 ft. 3 in., and depth, 27 ft. She is schooner-rigged, and is fitted with quadruple expansion engines to develop 3,200 I. H. P. Steam is supplied by two Scotch boilers, fitted with Ellis & Eaves draft. P. A. B. Widener, of Philadelphia, is the owner, and he is a member of the New York Yacht Club. The yacht will be very luxuriously fitted and finished, and it is reported will cost, when completed, about $500,000. The former yacht of this name, owned by Mr. Widener, was sold to the Government during the Spanish war period and renamed the *Vixen*.

At the Norfolk Navy Yard the torpedo-boat *Talbot* is being equipped with oil burning apparatus for the purpose of carrying out a series of experiments in the use of fuel oil. The trials will probably be made on Chesapeake Bay.

STEAM PIPES ON VESSELS—MATERIALS USED AND CAUSES OF FAILURES.—II.*

BY J. T. MILTON.

IRON AND STEEL PIPES.

The properties of wrought iron, mild steel and cast iron are too well known to require lengthened description. In making either wrought iron or mild steel welded steam pipes the tubes are made from rolled strips or plates, the edges of which are beveled by machine, and the weld is always lap, not butt. In all but the largest sizes the welding is done in rolls at one heat the whole length, but in the largest sizes of pipes it is done piece by piece, in a similar way to the welding of boiler furnaces. In wrought iron a free welding quality is usually selected in preference to a very strong iron, soundness of weld being considered to be of the first importance. In mild steel the very mildest qualities are selected for the same reason. With either material the requirements of manufacture, except in the cases of the very largest pipes, are such that the thickness is in excess of the requirements of strength for such steam pressures as are now in use, so that when iron or steel pipes are used a very large margin of strength is always provided.

In the case of wrought iron pipes it is usual to trust to the welded joint, but in the case of mild steel, in some cases a riveted butt strap has been fitted, as an extra precaution, over the welded joint. Experience, however, with steel lap-welded boiler and other tubes has shown that, with the mild qualities of material actually used, as reliable welds can be made with steel as with wrought iron. It need hardly be pointed out that butt straps add considerably to the weight and cost, and that every needless rivet hole is a possible source of leakage and trouble, so that if the welds are really efficient, and if they could be tested so as to practically eliminate the probability of defective workmanship, butt straps would soon be dispensed with.

To put such a high hydraulic test upon welded steel as would really stress the material to nearly its elastic strength is impossible, owing to the thickness adopted being much greater than is needed from the requirements of strength alone, and the fact that such pressures would strain the flanges and flange fastenings, but tests of three or four times the working pressure can always be made. It has been suggested by some pipe-makers that, to give confidence in the welds, each steel pipe should be made somewhat longer than is actually required, and that test pieces should be cut off from one or both the ends before flanging and opened out and tested in a testing machine across the weld. In addition, of course, a high hydraulic test would be made after the flanges are fitted.

Flanges for wrought iron or steel pipes may be welded to the pipes, but usually they are screwed on. In some cases they have been riveted to the pipes. Successful plans are shown in Fig. 3, in which the flanges have been forged out of the solid without weld, and screwed on the pipe with a diminishing thread. The thread extends through the whole thickness of flange, but in more recent practice the flange overlaps a part of

*A paper read at the Fourteenth Session of the Institution of Naval Architects, London.

the pipe without thread. In either case the flanges are caulked on both sides to ensure steam tightness.

When wrought iron or steel pipes are used the designs are generally made so that individual pipes are straight, or nearly so. It may be of interest, however, to know that if bent pipes are really required they can be made with a radius of three times the bore for pipes below 6 in. diameter and four times the bore for pipes up to 12 in.

CAST IRON STEAM PIPES.

In the paper of 1895 it was stated that cast iron steam pipes had been used with success for many years, and a list was given of several vessels in which such pipes were fitted, and the periods during which they were in use were also recorded. In most of these vessels the cast iron pipes are still in service. The almost invariable use of cast iron for stop valve chests, etc., shows that as a material it can be relied upon for strength and durability, and the experiences with the vessels referred to show that pipe designs can be made permitting the use of rigid material. When wrought iron or steel pipes have been used for modern vessels

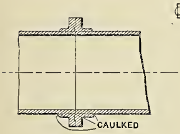


FIG. 3.

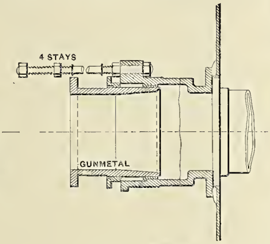


FIG. 4.

experience has shown them to be admirably adapted for their purpose, and no trouble whatever has been experienced with regard to their corrosion.

Having now discussed the qualities of the different materials used for steam pipes, it will be well to refer to the conditions which the pipes have to fulfil in actual use.

PIPES UNDER WORKING CONDITIONS.

The first condition to be noticed is that the pipes have to be strong enough to withstand the pressure to which they are to be subjected. In the case of wrought iron or steel, as has already been stated, conditions of manufacture require such a thickness that the strength is more than ample. Copper pipes, however, may easily be made of less strength than sufficient. The usual practice of marine engineers is to take the Board of Trade rule as a minimum. The rule is as follows:

Thickness in inches

$$=\frac{P \times D}{6,000}+\frac{1}{16}\text{in.}$$

for brazed pipes, and for seamless pipes not over 8 in. wide,

$$=\frac{P \times D}{6,000}+\frac{1}{32}\text{in.}$$

P being the working pressure in lbs. per square inch, and D the inside diameter in inches.

When making copper pipe, either from sheet or from straight lengths of tube, it is usual to make the bends from material one gauge thicker than would be used for straight lengths, and if the bends are very severe, to use two gauges thicker. This is necessary, as the material at the back of the bends is thinned in working. It must not be lost sight of that the extra thickness remains over the greater portion of the pipe, which is, therefore, rendered more rigid than it would be if it were uniformly of the minimum thickness.

Regarding questions of strength only, it is well known that in cylinders subjected to internal pressure the circumferential stress produced in the material is double that in a longitudinal direction. A pipe under hydraulic pressure will, therefore, always yield first by bursting open along the line of least strength, usually the seam. A reference to the failures which have actually occurred in practice, however, as given in the appendix, shows that most of the fractures occur circumferentially at or near the flanges, and are obviously due to longitudinal stresses. The causes of these must, therefore, be looked for from other than internal pressure.

The next condition to be noted is that when in use the pipes will be much hotter than when they are fitted up, or when not in use. The temperature of steam at 200 lbs. pressure—a common pressure now—is 388 deg. F. At 300 lbs., at which some boilers are being worked, the temperature is 422 deg., so that when in use the temperature of the pipes may be from 350 deg. to 390 deg., or even more, in excess of that at which they are fitted up. The co-efficient of expansion of iron or mild steel for a range of 360 deg. is .0024, and that of copper is .0037. Pipes, therefore, of these materials will tend to become longer when in use by these amounts. In addition to this the boiler itself, to which one end of the length of pipe is attached, also expands, and thus raises one end of the pipe from 3-8 in. to 1-2 in., according to the size of the boiler, while the end attached to the engine remains stationary. The necessary alteration of form of the pipes to allow for these expansions must be provided for in the design of the steam pipes, either by providing properly constructed expansion joints, which will allow the requisite freedom of motion, or by making the pipes of such form that the movements can take place, owing to the ductility of the material, without producing undue stresses on the pipes themselves, or in their connections to the stop valves and engines.

When cast iron or wrought iron pipes are employed it is usual to consider that their rigidity is too great to allow of the expansion to be accommodated by the flexibility of the pipes themselves, and generally, therefore, expansion joints are fitted to them. An example of such a joint is shown in detail in Fig. 4.

With copper pipes, however, it is more often considered that the pipes will be sufficiently flexible, and the material sufficiently ductile to permit of their repeated contraction and expansion without the need of stuffing-box expansion joints, and consequently these are rarely fitted. Undoubtedly pipes can be made sufficiently flexible to meet all practical requirements; but.

unfortunately, many of the designs in general use, sometimes combined with the faulty workmanship of not properly annealing the pipes, are such as to give continued trouble in keeping the flange joints tight, and in some instances also in producing rupture of the pipes at or near the flanges. Some of these designs will be presently referred to.

It must be borne in mind that the hollow cylindrical form is one naturally possessing great strength and rigidity in proportion to its weight, and hence its general use for columns, etc., where stiffness is required. This property is often forgotten when dealing with pipes, and they are often credited with far more flexibility than they possess. In questions dealing with the rigidity or flexibility of pipes it is well to remember that if a solid bar and a hollow tube of the same material, and the same length and shape, are subjected to the same loading, producing either traverse bending or torsion, or the two combined, the deflections will be identical if the diameter of the solid bar be equal to

$$\sqrt[4]{D^4 - d^4},$$

where D and d are the outside and inside diameter of the pipe. A bar of this diameter may, therefore, be looked upon as the equivalent of the tube when considering its flexibility, and if such a bar be flanged at the ends like the pipe, and attached to the stop valves, etc., by the flanges, the strains which the expansion, etc., will put upon the flanges of the stop valves will be the same by the bar or by the tube.

Let us now consider a pipe such as is commonly employed, say such as fitted in one of the cases referred to in the appendix. This pipe forms a right-angled bend, the two arms being 2 ft. and 6 ft. long, respectively; the inside diameter of the pipe is 6 in., and its thickness is .212, so that its stiffness or rigidity is equal to that of a solid bar of copper 4 1-8 in. diameter. The expansion due to its temperature would, if not resisted, increase the lengths of the two arms by over 1-12 in. and 1-4 in. respectively, and in addition one end is raised up by the expansion of the boiler about 1-2 in. The pipe, therefore, has to have such force applied to the flanges at the two ends as would bend a solid bar 4 1-8 in. diameter till the arms were shortened by the amounts mentioned, as well as place one end 1-2 in. vertically, and at the same time there must be such bending moments applied to the ends as will keep the flanges in the same plane. These forces have to be borne by the thin metal of the copper pipe at the parts where it is brazed to the flanges. If a larger pipe were considered the forces involved would be even greater in proportion. If the copper is at first well annealed these forces, being more than sufficient to produce stresses beyond the limits of elasticity, will doubtless permanently alter the shape of the pipe. At the parts where deformation takes place the copper will be somewhat hardened. When the pipe is cooled down it will tend to regain its original shape and length, and strains will be set up in it of opposite character to those caused by heating it. Each raising and lowering of steam will, therefore, bring alternating stresses on the pipe, each time tending to harden the material and decrease its ductility at those parts where most deformation takes place. There is no wonder, therefore, that in time the whole of the ductility is destroyed, and the pipe cracks round near one or both flanges.

From the diagrams shown in Figs. 1 and 2 it will be evident that, while on the one hand the more thoroughly annealed the material of the pipe is the more easily it will be deformed, yet, on the other hand, when well annealed the yielding power or ductility of the copper is such that very considerable deformation can take place without danger. Fig. 2, however, shows that with hard copper very much less yield can take place without the production of great strains, and consequently of great risk.

It may be well to point out that the expansion of iron is only about two-thirds of that of copper, so that the deformation in an iron pipe would be only two-thirds of that of a copper pipe; but, on the other hand, it is a stronger material, and in general, iron pipes would be thicker than those of copper, so that with iron there is considerably less flexibility than with copper.

When copper pipes have to take up the expansion and contraction by their alteration of form it cannot be too strongly urged that they should be anealed uniformly throughout their whole length. Unfortunately, the practice on this point is not well established. Some coppersmiths are particular in seeing that this is done; generally, however, only the bends, that is, the parts where the pipes have been bent and therefore extra hardened, are annealed, the straight portions being left unannealed, whilst other coppersmiths leave even the bends unannealed. The portions near the flanges always become annealed when the flanges are brazed on, and unless the pipes are afterwards annealed their whole length it happens that the whole of the deformation strains become concentrated upon the soft part at the flanges where there is the greatest tendency for rupture to be produced.

ANNEALING BENT PIPES.

From what has been stated it would appear to be desirable that copper pipes which have to take up expansion deformations should be periodically annealed. This, however, brings up the question as to how the annealing of a bent pipe can be effected. The workshop practice is at best a makeshift one, the usual and practically the only plan being to heat successive portions of the pipe over an open coke fire, the workman turning it round and shifting it about over the fire until each part in turn is thought to have been raised to a red heat. Irrespective of the difficulty of getting the inside of a large bend near the coke fire, this method leaves much to be desired, and involves a great risk of some parts being left hard, while the remainder is annealed. An unhomogeneous pipe may be in a worse condition than one wholly unannealed, and hence the reluctance of marine engineers generally to have pipes which have been satisfactorily at work for some time taken down and possibly injured in the attempt to anneal them. It is not too much to ask that our engineers should, if they will continue to use large and thick copper pipes, provide proper furnaces where the pipes may be uniformly heated throughout their whole length at one operation.

USES OF EXPANSION JOINTS.

There is, however, no absolute necessity in most

cases for using bent pipes. Straight pipes can nearly always be designed to meet all requirements, and the expansion of these can be provided for by expansion joints of the form shown in Fig. 4. These joints are, it is true, objected to by some engineers as being likely to be a continual source of trouble, but that this is not a correct view is shown by the fact that in our very largest mail boats they have been fitted and found to present no great difficulty in keeping them in order, while one of the largest engineering concerns on the East Coast practically used no other design for very many years for their main steam pipes, and their engines and arrangements are at least as popular as those of any of their competitors. Further, it must be remembered that, even if some trouble is experienced in keeping stuffing-boxes in order, serious troubles with leaky joints are by no means unknown, where the expansion has to be met by straining the pipes themselves. Figs. 5, 6 and 7 represent plans which have been successfully adopted for steam pipes in which all the pipes are practically straight and the expansion provided for by expansion joints.

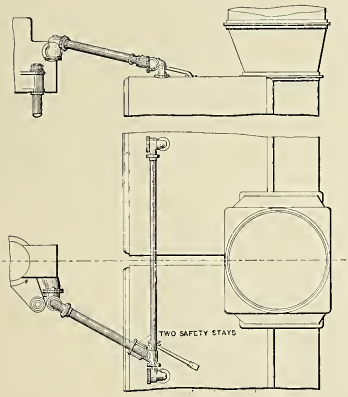


Fig. 5.

In providing for the expansion to be taken up by expansion joints it is necessary to insure that the lengthening of the pipe shall really take place by pushing into the joint meant to receive it, and that, on the contrary, the end of the pipe shall neither be stationary in the joint nor drawn out of it. This can only be insured by making arrangements for fixing the expansion joint in position, and also securing the other end of the pipe to a fixed position, either by means of long stays attached to the expansion joint itself, or by some other means.

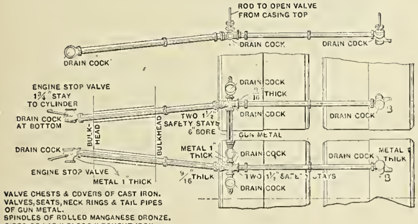


Fig. 6.

The blowing out of the pipe by the steam pressure may possibly take place if there is a large bend in the pipe, as is seen in some designs. In such cases the preventive fastening should be secured to the bend, not to the pipe near its free end. Expansion joints are often fitted with what are called safety stays to prevent the pipe being blown out. When these are short and fitted too near the free end of the pipe they are either useless or the expansion joint itself is useless, as they cannot come into service if the pipe expands into the joint, as it is intended to do. They may, moreover, be an absolute source of danger, and at least one of the failures of steam pipes recorded was due to their being fitted. When steam is up and the pipe expanded the safety flange should be some distance off the nuts of the stays. If in this condition the nuts are thoughtlessly or ignorantly screwed up to the flange, on the pipes cooling down and contracting they will be subjected to great strains and something must fracture to relieve them. If such stays are fitted, therefore, the nuts on them should be carefully adjusted when cold and be fixed in place, either

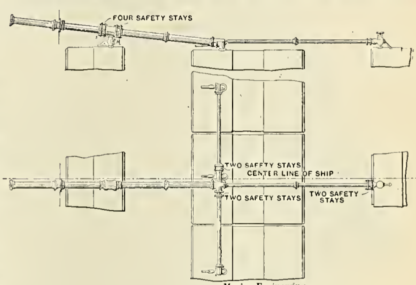


Fig. 7.

by pins through them or by ferrules placed over the stays of such a length that the nuts cannot be screwed down too far. Properly designed pipes, however, will not need these stays at all. In none of the plans shown in Figs. 5, 6 or 7 are these stays really required, although they have been fitted.

SUPPORTING STEAM MAINS.

Whilst referring to the expansion of pipes it will be well to call attention to the methods of supporting long lengths of pipe. These should be so arranged that, while giving the necessary support and preventing vibration, they will not of themselves prevent the movement of the pipes due to their expansion and that of the boilers. If this is not provided for the supports may possibly put much greater stresses on the pipes than would result from their being left altogether unsupported. Unfortunately, this point is often neglected by the designer, the hangers being arranged on the vessel by the mechanics who fit them in place, who may not fully appreciate all their requirements.

EXPERIMENTAL MODEL BASIN AT WASHINGTON, D. C., FOR THE U. S. NAVY.

In our issue of March, 1898, we published a brief description of the model experimental tank at Washington, then under construction for the Navy Department, together with photographs showing the progress of the work. Now, through the courtesy of Rear-Admiral Philip Hichborn, Chief Constructor of the Navy, we are enabled to publish a description of the completed station with illustrations of the principal apparatus employed.

The value of towing experiments upon small scale models of ships for the purpose of deducing the resistance of a full sized ship from that of the small model was demonstrated by the late William Froude, who, at his own expense, started a small tank for such experimental work at Torquay, England, about 1870. The English Admiralty subsequently recognized the value of his work and assisted him in it, later building a larger basin at Haslar, near Portsmouth, which is now in charge of R. E. Froude, son of William Froude. Other governments, notably Italy and Russia, were induced to establish model basins, which were largely copies of Froude's basins; and one firm of private builders, Denny Brothers, of Dumbarton on the Clyde, Scotland, was sufficiently enterprising to build a basin for their own use.

The Construction Bureau of our Navy Department has appreciated for many years the value of an experimental basin, but it was for a long time unable to secure an appropriation for the purpose. Congress finally, about two years ago, granted $100,000 for this work, the grant being largely due to the efforts of the late Congressman Hilborn. The basin proper was completed the latter part of last year, and the special machinery and apparatus have now just been completed and installed, after a good deal of delay due indirectly to the war with Spain.

The basin is located in the southeast corner of the Washington Navy Yard. The building is 500 ft. long and about 50 ft. wide inside. The water surface of the basin is slightly shorter than the building, being about 470 ft. long. The deep portion is about 370 ft. long, the south end, from which runs begin, being shallow. The water surface is 43 ft. wide, and the depth from top of coping to the bottom of the basin is 14 ft. 8 in. The basin is considerably larger than any other in existence. The nature of the ground was such as to render the construction of a thoroughly tight and stable basin somewhat difficult, but owing to the small space available at the Washington Yard, it was necessary to locate it upon its present site. The bottom of the basin proper is made up of a layer of broken stone upon which is a thin layer of concrete, then 1-2 in. Neuchatel asphalt, then about 9 in. of concrete in 16 ft. lengths, the keys between the various lengths being filled with Bermudez asphalt, and the whole inside surface covered with the asphalt. The heavy side walls are 6 ft. thick at the bottom, 6 ft. deep, and about 4 ft. 6 in. thick on the top, not counting the moulded stone coping. They are in 40 ft. lengths with a square key between adjacent lengths filled with Bermudez asphalt. The side walls rest upon a double row of piles, and in addition there is sheet piling completely around the deep part of the tank. The shallow part of the tank at the southern extension is also carried on piling, as it actually overhangs the water.

The law authorizing the construction of the model basin also authorized experiments to be made for private shipbuilders, provided they defrayed the actual cost of the same, it being understood, of course, that such experiments should not interfere with naval work. This being the case, it was necessary to lay out the plant with a view to the rapid and economical turning out of routine experiments, and to this end the endeavor has been throughout to use machinery for as many of the operations as possible. The foreign tanks invariably used paraffine for the construction of models, and generally make them from 10 to 14 ft. long. The climate of Washington is so warm in the summer that it was found impossible to obtain paraffine which would retain its rigidity satisfactorily, and, moreover, it was the desire of the Bureau of Construction and Repair to make the models as large as possible, thus eliminating one source of inaccuracy in applying the model experiments to full-sized ships. For these reasons wood was adopted as the material for the models, and after some difficulty a satisfactory varnish was found which rendered the surface of the wood to all intents and purposes absolutely water tight. The standard length of model used is 20 ft. A model 20 ft. long may not seem much larger than one 12 ft. long, but when it is remembered that the displacements of these two are respectively as 8,000 and 1,728, it will be seen that the 20 ft. model is nearly five times the size of the 12 ft. model.

The method of building the models is as follows: The "lines" of the ship invariably include a body plan giving sections at moderately close intervals. From this body plan new sections are drawn to the proper size for a 20 ft. model by means of the eidograph or large pantograph. These sections are cut out of paper, then transferred to wooden boards, which are sawed to shape. These boards are then erected in their proper relative position upon the erecting table, each board section being clamped in a vertical plane. They are then covered with battens about 1-2 in. thick and tapering from amidships towards the end, making a "former" model, the surface of which is planed smooth. In cutting out the sections allowance is made for the thickness of the battens, which have to be nailed upon them. Meanwhile a rough block of shapes and dimensions to enable the finished model to be cut from it has been prepared and glued together under pressure in a large hydraulic press. This block is placed upon the upper table of the model cutting machine, the "former" model being placed upon the lower table. The model cutting machine works upon the principle of the Blanchard lathe, a roller traversing the surface of the "former" model, and saws, or cutters, working upon the surface of the model proper. The bulk of the material is removed from the block by means of the saws, which are shifted along a short distance at a time. Rotary cutters are then applied which finish the surface of the model very close to the desired shape. The model is then removed from the cutting machine and finished by hand; a very small amount of hand work,

however, being found necessary. It is then ready for varnishing and the attachment of any appendages, such as bilge keels, struts, etc. It is finally taken to the measuring machine and careful measurements made of its exact form and shape, which not only enable the staff to determine whether the model represents the lines desired, but give an exact record of the actual shape.

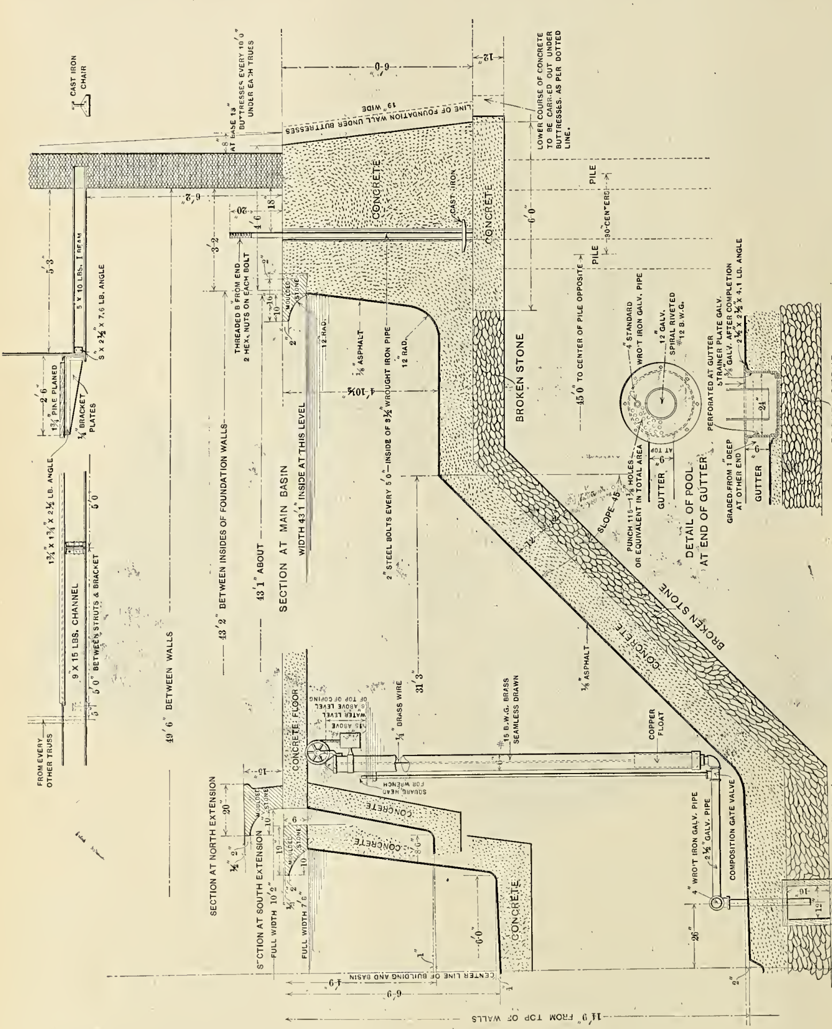
The model is now ready for the towing experiments. In the accompanying engravings the carriage used for this purpose is shown. It runs upon eight wheels and spans the full width of the basin, as shown. The platform in the center carrying the recording apparatus can be raised or lowered at will. Electricity is used to drive the carriage, and it may be mentioned, incidentally, that it is used for all mechanical work in connection with the model tank. The speed of the carriage is varied not only by making various combinations of the four motors—one to each pair of driving wheels—but by controlling the output of the generator in the power station, which is perhaps 100 yards from the tank. This control is on the Ward-Leonard system, and is very similar to that used to control the motion of heavy turrets on board ship. By means of a resistance box on the carriage the current through the field coil windings of the generator is increased or decreased at will. The revolutions of the generator being kept constant by a delicate governor the amount of current generated varies with the amount of current through the field coils of the magnet. The whole of the current generated is passed through the motors, and in practice it is found that a very exact regulation of speed is obtained by this combination. The carriage itself, with its fittings, weighs in the neighborhood of 25 tons, so that it alone forms a kind of fly-wheel and is not subject to sudden variations of speed. The speed of the carriage can be varied from 1-10 knot an hour, or 10 ft. per minute, to 20 knots an hour, or 2,000 ft. per minute. The principal difficulty in connection with the use of high speeds, which, while not necessary for the bulk of the experiments, will be of great value in certain special experiments, is to stop the carriage when it is once under way. The electrical control acts as a brake, because when the current is shut off the motors become generators, but this could not be relied upon for high speeds, since the sudden rush of current due to possible unskillful manipulation would throw the circuit breakers, thus opening the circuit and cutting off the current entirely. For these reasons there is at the north or terminal end of the basin a double system of brakes to take hold of the carriage. The first is a friction brake consisting of two strips of iron on either side, pressed together by hydraulic cylinders. These are forced apart by a slipper on the carriage about 10 ft. long, which, as well as the brake strips, is kept thoroughly oiled, so that the coefficient of friction for stop-

Exterior of model experiment station.

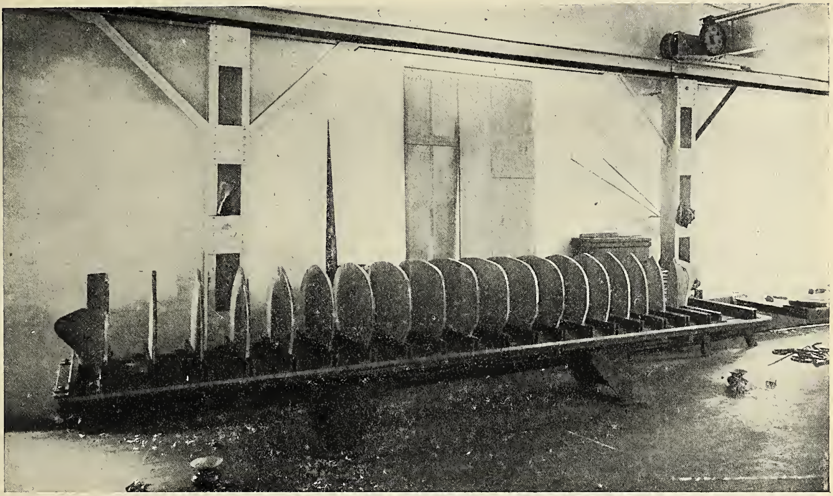
Recording table and instruments on carriage.

General view of interior, showing carriage across tank.

ping, though low, is fairly definite, and sudden jerks are avoided. The pressure in the hydraulic cylinders is controlled by an accumulator and a pump driven by electricity. Great care has been taken in connection with this part of the installation that it may be always in working order, and any trouble or breakdown, except that of the pump itself, which runs all the time, will simply result in setting the pressure at a maximum. This maximum is 600 lbs., but it has been found by actual experiment that with 500 lbs. pressure the carriage is brought safely to rest when it enters the brakes at a speed of 20 knots. It is not expected in practice to repeat this often, since even for the high speed runs the electrical brake will be used to reduce the speed of the carriage before the friction brake is used. In addition to the friction brake there is what is called

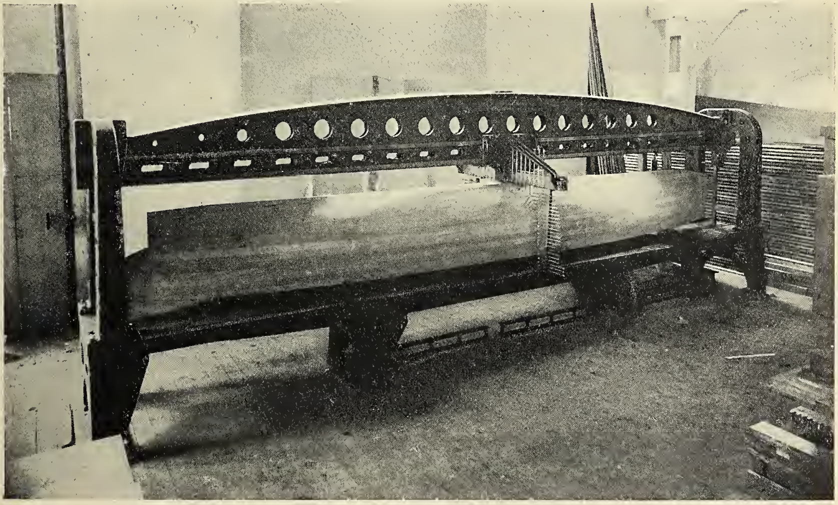


U. S. EXPERIMENTAL MODEL BASIN IN WASHINGTON, D. C.—DETAIL OF BASIN AND COPI'G,



ERECTING TABLE WITH CROSS SECTIONS OF "FORMER" MODEL IN POSITION.

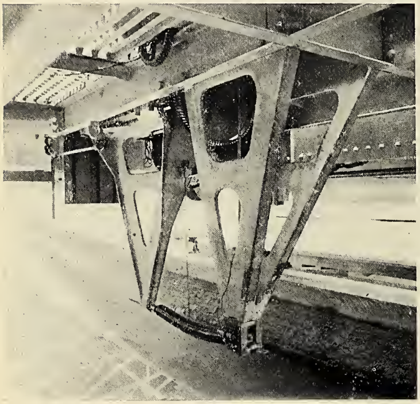
the emergency brake, so that in case the friction brake fails for any reason, the carriage would still be caught. This brake consists simply of a piston about 16 in. dia., working in a cylinder which is submerged in the water of the tank and connected by wire cables to a hook which takes hold of the carriage. The head of the cylinder has a round hole and the piston rod is tapered so that as the rod is drawn out by the motion of the carriage the hole is gradually closed, the whole being almost exactly upon the principle of the hydraulic gun



APPARATUS FOR MEASURING THE EXACT FORM OF THE FINISHED EXPERIMENTAL MODEL.

recoil brake. An escape is provided for the water around the piston when it starts from rest, to avoid sudden accelerations from the whole mass of water in the cylinder.

The dynamometric apparatus is designed to avoid entirely the use of multiplying levers or other devices involving the possibility of friction, and here again elec-

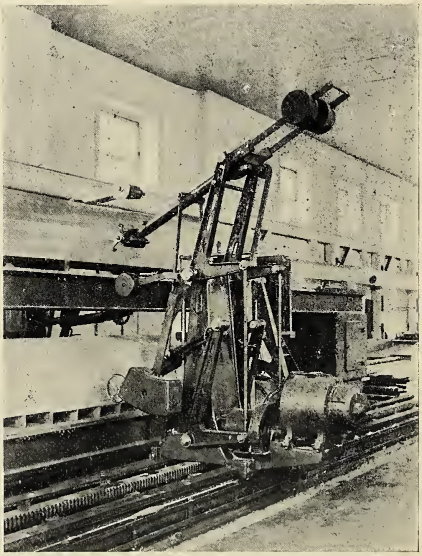


TOWING BRACKET UNDERNEATH CARRIAGE.

tricity is enlisted. The recording drum is fitted with apparatus for recording the time and distance, as usual. The resistance is measured directly by a spring which is in view underneath the carriage. The forward end of the spring is attached to a bracket which is screwed forward or back by an electric motor, and a rigid arm runs up from the bracket, with a pencil recording its position on the drum. The record then is of the position of the forward bracket. The after end of the spring takes hold of a small cross-head to the other end of which again is attached a towing rod which takes hold of the model. This cross-head has a very slight play between stops in the after fixed bracket, and when it touches either stop closes an electrical contact, which again throws an electric clutch, by means of which the motor, running all the time, screws forward or back the forward bracket, thus increasing or decreasing the tension of the spring until the contact is opened again.

There are many refinements which cannot be indicated in this brief description; for instance, the operator can throw either clutch at will or set them to work automatically. In practice, when about to make a run, the operator works the bracket forward to the immediate vicinity of the position which he knows it will assume during the run, the approximate speed of which he knows. The carriage is then started, and after a uniform speed has been obtained, which, for speeds up to 12 knots, is done within 50 ft., he throws in by a single motion of one handle the automatic appliances which start the drum and record time, distance and resistance. In this way the resistance pen has to move but a small distance to reach the position of equilibrium and almost immediately becomes steady. It will be seen that with this device friction is eliminated. The accuracy obtainable depends upon the closeness with which the automatic stops at the after end of the spring can be set. In practice it is found that these can be set to give a play of about the fiftieth of an inch, and as the springs will extend 10 in. the results obtained are practically exact as indicating the pull of the spring.

It now remains to describe the method by which the amount of this pull can be determined in any instance. There is fitted at the starting end of the basin a kind of weighing machine with one vertical and one horizontal arm. This is delicately balanced, and when the model has been connected up and is ready for towing, a certain spring being in use, the vertical arm, or rather a knife edge which bears upon the vertical arm, is connected to the model. A known weight is then put into the scale pan attached to the horizontal arm. The automatic attachment in connection with the dynamometer spring is thrown into gear, and the weighing machine is screwed forward or backward until it is in perfect balance and the record pen recording the position of the spring is at rest. It is evident then that the pull of the spring is exactly equal to the weight in the scale pan. There are a number of pens which can be shifted parallel to the recording pen and set in a definite position to record upon the drum. One of these pens is set to correspond to the position of the



MODEL CUTTING MACHINE.—"EXPERIMENTAL MODEL" ABOVE, "FORMER MODEL" BELOW.

resistance pen, then another weight is put into the scale pan, a second pen set to record the resistance, and so on. It is evident then that when the run is made these fixed pens mark off upon the paper a scale

for resistance, avoiding all complications of corrections for temperature of spring or anything else. A complete double outfit of springs is already provided for measuring resistance from 1 lb. up to 500 lbs., and for special work additional special springs will be obtained.

In connection with the question of temperature, it is impossible to avoid a certain variation of the temperature of the water, but as ample heating facilities are provided, it is not expected that the variation of temperature during the year will be sufficient to necessitate correction in the results of experiments on this account. The basin is filled from the water system of Washington and will hold one million gallons. Two electrical centrifugal pumps are provided, the larger of which will empty the tank in about four hours. The smaller pump is a 4 in. pump used for draining the last water from the basin and also for pumping the water from outside the basin to avoid the possibility of undue pressure upon it in case it is left empty for some time. This is necessary, since the basin is but a short distance from the Potomac river and extends 8 or 9 ft. below mean tide level. A gauge indicates the level of the outside water, which is found to be, as a rule, about 6 ft. below the water in the basin.

The leakage from the basin, which is very slight, and the evaporation, are made up with filtered water, an animal bone filter being installed with a capacity of from 50 to 100 gallons per minute, depending upon the turbidity of the water. In practice a small stream of fresh filtered water is kept running into the basin all the time, and the level maintained wherever desired by an adjustable overflow.

The building and tank or basin proper were designed by the Bureau of Construction and Repair, as well as the machinery for making the models. The electrical installation was fitted by the General Electric Company, many of the electrical details of design being also due to them. The carriage proper was built by the William Sellers Co., the dynamometer apparatus partly by the Sellers Co. and partly by Saegmuller, of Washington, who also built the large eidograph. All of these are upon the designs of the Bureau of Construction and Repair. The model cutting machinery was built by Detrick & Harvey, of Baltimore, Md., to the designs of the Bureau of Construction and Repair.

The model basin staff is now at work upon experiments to determine frictional coefficients of varnished surfaces and other constants needed in its use. Experiments are being made as opportunity serves upon models of the naval vessels already built and tried for the purpose of accumulating data which will be constantly needed during the life of the tank. As soon as preliminary lines of the new third-class cruisers authorized at the last session of Congress are completed, experiments will be made with them in the tank with a view to introducing any refinements or improvements found desirable.

According to *The Steamship,* "a Belgian engineer has invented a hydraulic propeller for ships which, it is claimed, attains a speed of 40 knots per hour without increasing the consumption of fuel. It is intended to fit the invention to a large steamer, and a run to America and back is to be made, with the object of demonstrating its superiority over the ordinary screw propeller."

AMERICAN SCHOOLS OF MARINE ENGINEERING.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS AT SCRANTON, PA.

Courses of Instruction for the Benefit of Operative Marine Engineers and not Designers—Tuition by Mail Exclusively.

The International Correspondence Schools of Scranton, Pa., hold a unique place among educational institutions. Their courses of instruction in the engineering trades and professions are developed exclusively through the mails; their students are in every part of the world and engaged in regular business pursuits; and most of them have passed the age at which the educational period is generally considered to have terminated. The plan has, however, passed far beyond the region of experiment, and a growth of from one student to 90,000 in less than eight years is sufficiently indicative of its popularity and of the confidence which it has inspired.

The method of correspondence instruction, upon which the schools have been established, was originated in 1891 by Thomas J. Foster, manager of The Colliery Engineer Company. Its origin and location of the schools at Scranton are due to the demand on the part of the miners, in that section, for educational assistance to enable them to pass the mine-law examinations. From a single course in mining and a series of papers prepared by a single instructor, the system has been expanded to cover almost the entire range of technical knowledge with fifty-seven distinct courses of study, and a corps of 120 engineering experts, instructors and assistants, who write and edit the texts used in teaching, and examine and correct the work of students. These are in addition to the subordinate assistance required to carry out the purposes of the system, the business management and its assistance, and the working force of the home office and elsewhere, which bring the entire staff and line of the schools up to about 1,000 persons.

The Marine Engineering Course of the International Correspondence Schools is intended primarily to supply such knowledge to men in the engineers' department of steam vessels as will assist them in becoming engineers or obtaining a higher grade of license. No attempt whatsoever is made to instruct students in the use of tools, instruction being limited to those branches of science a knowledge of which, for obvious reasons, can not be obtained by actual work in the engineers' department. For instance, students are not taught how to file up a cut crank pin. They are, however, taught the use of the indicator, how to read cards, the elements of propulsion, the chemistry of combustion, the principles of steam generation, the use of the salinometer, the theory of compounding engines, the use of condensers and many other similar matters, which in former days had to be learned by self-study or not at all. Owing to the fact that instruction is given entirely by mail, the method of teaching differs entirely from that employed at technical schools. The requirements for entrance are simply the ability to read and write the English language.

THE COURSE OF INSTRUCTION.

Upon enrollment a student is started in the preparatory division, it being assumed that he knows nothing whatever beyond reading and writing. For obvious reasons, it is essential that a student must be well grounded in the fundamental principles before their application can be taught to him. Numerous examples of a practical nature, distributed all through the text-books which the schools furnish free of charge to students, serve to make him familiar with each and every principle and its application. The greatest divergence of the method employed in correspondence instruction from that in vogue in colleges lies in the fact that there is no set time for study, or that any division must be completed within a prescribed time. Each and every student is a class by himself, and studies independently from others. When any part of any division has been completed by a student, he is required to pass a rigid examination, at which he must have an average of 90 per cent to pass. This examination naturally is a written one, and consists of from fifty to one hundred questions covering all parts of any branch of any division, and so worded as to bring out fully a student's knowledge of the principles he has been taught. In examining the answers to these questions the greatest of care is exercised; not only is the final answer checked, but the reasoning and the methods employed by the student in order to arrive at the solution are investigated thoroughly. This can readily be done, as students are absolutely required to work out every example or question in full.

Naturally some students enrolling either for the Marine Engineering or any other course object to starting in at the beginning, claiming that inasmuch as they have been taught the rudiments of mathematics at public schools years ago, they should not be required to go over the same ground again. In such a case the schools give the student the option of taking an examination; if he passes it successfully (90 per cent. being required) he may take up the next division. However, most students find it to be greatly to their own interests to review the rudimentary knowledge contained in the preparatory and intermediate division before taking up the advanced division. But it is an inviolable rule that a student must, by passing a rigid examination, prove that he thoroughly understands one division before he can enter upon the study of the next one. In the advanced division of the Marine Engineering course students are taught as much of the science of Mechanics as required. Upon completion of the advanced division, the study of Geometrical, and practice of Mechanical Drawing is entered upon. Here the student is taught the Use and Care of Instruments, Geometrical Constructions, Representation of Objects, Orthographic Projection, the Conic Sections, Intersections and Developments, etc. When finished, the practice of Mechanical Drawing is taken up. Here special attention is paid to making the student familiar with the production of working drawings, one of the last drawing plates of the course being a complete component of the machinery equipment of a vessel drawn to correct scale. For example, a student is required to prepare a complete working drawing of a double-ended marine boiler; the plate sent to the student being reduced enough to break the scale, and the student being required to make his drawings to the scale marked. Copying is impossible. Furthermore, in drawing these plates the student finds it necessary to do quite a little projecting from one view to another in order to obtain the correct position of lines and points in the various views—the dimensioning of the parts shows him, and makes him familiar with the dimensioning of working drawings.

It has been found advisable to make it optional with the student whether to take Geometrical and Mechanical Drawing before or after the advanced division, but in all cases the drawing division must be completed before entering upon the technical division.

Upon entering the technical division the students commence with Thermodynamics, then taking up the Properties and Generation of Steam. Next, the types of Marine Boilers are studied; then Boiler Construction and Design, Fittings of Marine Boilers, the Feed Apparatus, Feed Pumps, Feed Water Filters, Strainers, Grease Extractors, Heaters, Evaporators, the Salinometer, Combusion and Fuels, Circulation of Water and Forced Circulation Apparatus, Natural and Forced Draft, Rates of Combustion and Management, Care and Repairs of Boilers; also Boiler Explosions and Boiler Tests.

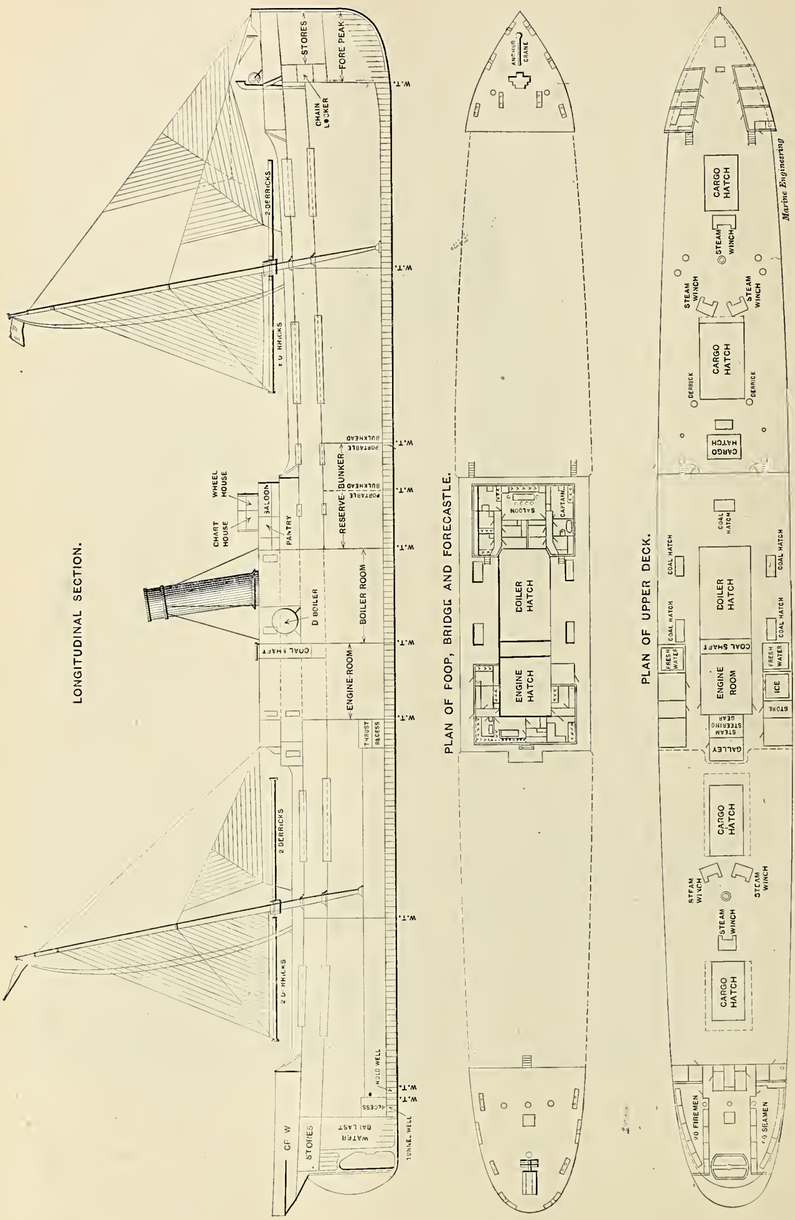
The student now enters upon the study of the use of Steam, commencing with Work and Expansion of Steam. Then the Steam Engine is taken up, and Steam Distribution, Valves, Valve Gears and Valve Setting are followed by the Elements of Propulsion. Upon completion of this part the Indicator, Steam Consumption, Efficiency of Steam Engines, Condensers, Air Pumps, Compounding of Engines, the Beam Engine, the Engine Room Fittings, etc., followed by Management, Care and Repair of Engines are taken up fully. This branch of study is followed again by instruction in Electricity, commencing with the fundamental principles.

Upon completion of the studies the student is then required to pass a rigid general examination covering all branches studied; if passing the same with an average of 90 per cent. a diploma is issued, showing that the student has completed the prescribed studies. This diploma does not carry a degree with it. No attempt is made in the Marine Engineering course to fit men for designers of marine machinery or to make naval architects of them, instruction being rather of such a nature as will make men better qualified in all respects to intelligently care for marine machinery and run the same economically. The principal of the school of marine engineering is John A. Grening, who commenced life as coal passer on the S. S. *Tijuca*, of the Hamburg-South American S. S. Co., and rose step by step to his present position.

The New Pacific Liners.

The Hawaiian Steam Navigation Co. has recently contracted for a fleet of large, modern steel cargo steamers with John Roach & Sons, Chester, Pa., and the Union Iron Works, of San Francisco. Each yard will build two vessels, and these steamers, being of a very successful money-earning class and size, much interest is centered in them. The design and specifications for these vessels were prepared by Flannery &

MAIN BUILDING OF THE INTERNATIONAL CORRESPONDENCE SCHOOLS, SCRANTON, PENNSYLVANIA.



INBOARD PROFILE AND DECK PLANS OF NEW STEEL STEAMSHIPS FOR HAWAIIAN STEAM NAVIGATION CO.

Tritton, naval architects, Water street, Liverpool, Eng. They are each of the following dimensions:

Length over all	430 ft.
Length L. W. L.	415 ft.
Beam	50 ft.
Depth, side	33 ft. 6 in.
Depth, center	34 ft. 6 in.
Load draft	26 ft.

The scantlings of the vessels will be in accordance with Lloyds' three-deck rules, and they will receive the highest rating in this classification society. Each vessel will be fitted with two pole masts, with four large derricks on each mast. Vent derricks will also be fitted. There are four large cargo hatches, and one smaller one. The forward hatch, No. 1, is 21 ft. long and 12 ft. wide. No. 2 hatch is the largest in the ship, being 30 ft. by 16 ft. A small hatch—No. 3—12 ft. by 10 ft., leads to the reserve bunkers. Abaft the bridge house is No. 4 hatch, 25 ft. long by 12 ft. wide, and the after hatch, No. 5, is 21 ft. long by 12 ft. Seven double drum steam winches will be fitted, and all the appliances for the rapid handling of cargo will be modern and most complete.

The designs call for seven complete steel water tight bulkheads and one partial bulkhead. A double bottom extends from the collision to the aft peak bulkhead, the tanks in this water bottom having a capacity of 1,250 tons of water.

The vessels are of the three decked type, and two of the decks are plated with steel throughout. They have a forecastle, midship house, bridge house and full poop. The forecastle is open at the aft end, but in the inclosure are located the carpenter's shop, paint shop, boatswain's stores, lamp room, etc. The steam windlass is located on the forecastle deck in the open. The chain lockers and forward storeroom are located over the forward trimming tank. The forward part of the midship house will be used for the stowage of cargo. Large coal trunks lead from the main deck to the bunkers below. In the aft of the midship house, alongside the engine casing, are fresh water tanks, ice rooms, storerooms, steam steering gear, galley, oilers' room, water tenders' room, etc. Above the midship house is the bridge house. Around the engine hatch in the bridge house are six officers' staterooms, a mess room, pantry, bath and w. c. Forward of the boiler hatch are the staterooms for the captain, first officer and steward, also three passengers' staterooms, toilet rooms, pantry and large saloon. Situated above the forward part of the bridge house is the chart and wheel house and navigating bridge. The crew are berthed in the poop aft. Twenty sailors have roomy quarters on the starboard side, and twenty firemen and coal passers a similar room on the port side. Convenient wash rooms and w. c. are also located here.

The propelling machinery of each vessel will consist of a vertical triple expansion engine with cylinders 27 in., 45 1-2 in. and 76 in. by 48 in. stroke, designed to indicate 2,500 I.H.P. at sea. Steam will be supplied by four large steel Scotch boilers, each 14 ft. 9 in. dia. and 10 ft. 6 in. long, working with natural draft, with a common stack 80 ft. high above the grate. A large donkey boiler 9 ft. 6 in. dia. and 10 ft. long, built for 90 lbs. pressure, will also be supplied. The coal bunker capacity is 1,500 tons, including the reserve bunker. An electric plant with a capacity of 100 16 c. p. lights will be supplied, and the vessels will be well equipped in every respect. They have been designed to carry 8,250 tons dead weight on a draught of 26 ft. at a mean sea speed of 10 knots per hour. In smooth water and under favorable conditions these vessels should be able to steam at the rate of about eleven knots when fully laden.

U. S. TORPEDO BOAT ROWAN, WITH SPEED RECORD OF 27-2 KNOTS.

Moran Bros.' Pacific Coast Yard.

Facilities for local steamer traffic afforded by the waters of Puget Sound, and the constantly increasing number of steamers plying thereon, have always stimulated the growth of small marine engineering establishments along its shores. And now a rapidly increas-

ing foreign trade, making its American terminus here, is creating a demand for facilities for building and repairing ocean-going vessels.

The most important marine engineering plant at present on the Sound is that of Moran Bros. Company, situated at Seattle. It is the outgrowth of a small repair shop established here in 1881 by the Moran Bros., and it has steadily advanced till it now occupies a foremost position among marine engineering establishments in the Pacific Northwest. The shops and yards cover an area of fourteen acres, having a frontage of 700 ft. on Elliott Bay. The buildings, which are mostly of wood, include machine shop, pattern shop, foundry, blacksmith and boiler shops, as well as pipe, copper and other auxiliary shops, necessary for a complete marine engineering works. They are all fairly well equipped for the construction and repair of moderate sized vessels, particularly the foundry, which has overhead traveling cranes, and can handle good sized work, as, for example, the centrifugal pumps built for the United States Government dry-dock at Bremerton, Wash. Each of these pumps has a capacity of 110,000 gallons per minute, against a head of 28 ft., the discharge nozzle being 42 in. dia. The boiler shop is equipped with pneumatic caulking and riveting tools, and has bending rolls which can handle plate 10 ft. wide by 1 1-2 in. thick.

In the yards both steel and wooden hulls are constructed, an abundance of the finest kind of ship timber making facilities for the latter a necessity. A marine railway, which can haul out ships of 1,000 tons, is at present the only docking equipment.

One of the largest orders ever filled by this concern was for twelve stern wheel steamers for the Yukon river trade, which at the time of their completion, a year ago, we described and illustrated. Their main dimensions were: Length, 175 ft.; breadth, 35 ft.; depth, 6 1-2 ft. They were all alike, and rested on the same launching ways, the direction of launching being sidewise. Each steamer was equipped with engines having cylinders 20 in. dia. by 7 ft. stroke. The total time of construction of the whole fleet, including machinery, was five months. Another important contract completed by this firm was the construction of the United States torpedo boat *Rowan*, which has lately been accepted by the Government, and is shown in the accompanying illustration. Her maximum trial speed was 27.2 knots per hour. At present Moran Bros. are building their forty-eighth vessel, a steel tug-boat 128 ft. long, for the Puget Sound Tug-boat Co. They also have a smaller steel tug-boat under construction for other parties.

The present plant has, however, proved too small for increasing business, and new shops and yards are now in course of construction. As much of the hull work will be of wood, a large saw-mill has been erected, and is nearly ready for operation. In this they expect to manufacture from the log all the lumber needed for the yard, not only for the hull proper, but for all such work as deck-houses, with furnishings, sashes, doors; all woodwork required for a complete ship. This mill is placed near the yard, yet far enough away as not to endanger it or the shops in case of fire. It will run steadily; the surplus product will be placed on the lumber market, and the refuse, waste and sawdust will be used as fuel in the yard boilers, making a very economical arrangement.

The new shops will be driven by electricity, from a central station placed near the mill, and electrical distribution of power will be used as far as possible. These new shops are now in course of erection. One building, 96 ft. wide and 700 ft. long, is to contain the machine shop, foundry and blacksmith shop, overhead cranes, having a clear span of 36 ft., traversing the entire length of the building. The tools on hand will be transferred to the new shop, and many new and larger ones added. A 6,000 lb. hammer is now being placed in the new shop, and a 24 ft. plate planing machine in the yard.

The water front is to be remodeled, so as to give a total wharf front of 4,000 ft. A floating dry-dock 400 ft long, in two sections, is to replace the marine railway. Each section will be 200 ft. long, and small ships can be docked with one section. This dock, in conjunction with a new 75-ton crane, will provide for docking and repairing any ship now on the coast.

The new plant is to be equipped throughout with all modern appliances, and will be large enough to build and repair either steel or wooden ships of large tonnage.

The officers of the company are: President and general manager, Robert Moran; Trustees and also stockholders, William Moran, Frank Moran, and Sherman Moran. The growth of the place from a small shop to its present dimensions is mainly due to the perseverance and energy of its President, Robert Moran.

New Ship Yard at Camden.—Work is being pushed on the fitting out of the new ship yard at Camden, N. J., established by the New York Shipbuilding Company, of which Henry G. Morse is president. This company was organized last March, and subscriptions amounting to $3,000,000 were received from stockholders residing in New York, Philadelphia, Wilmington, Baltimore, Pittsburg and Youngstown, O. The board of directors consists of Henry G. Morse, Woodburn, N. J.; H. Walters and W. Jenkins, Baltimore, Md.; A. W. Melton and James H. Lockhart, Pittsburg, Pa.; M. C. Wick and J. Craig Smith, Youngstown, O. The Treasurer and Purchasing Agent is Charles S. Hall, and the Superintending Captain W. G. Randle, formerly of the American Line. Aside from the President, Henry G. Morse, the other officers have not been elected. The yard has been located at Camden, N. J., opposite Philadelphia, where the company has purchased 120 acres, having a frontage of two-thirds of a mile on the Delaware River and a depth of 1,500 ft. from the pier line at the narrowest point. The property is unobstructed by streets or railway lines. There is ample depth of water, the depth at the pier line being 40 ft. at low tide and 46 ft. at high tide along the entire water frontage, and directly in front the ship channel is 2,000 ft. wide. The plant was laid out by Mr. Morse, and on July 3 active field work was begun. Contracts for preliminary work and equipment to the amount of $1,200,000 have been made. The yard is being laid with a view to the construction of ships of all classes and sizes now built, and with sufficient capacity for any probable increase in size or requirements which may be demanded in the future.

At a preliminary speed trial of the torpedo-boat *Dahlgren*, built at Bath, Me., a speed of 29.75 knots was attained.

CONSIDERATION OF THE INDICATOR AND ITS USES ON BOARD SHIP—VI.*

BY R. W. JACK.

In the case of a high-pressure engine, the superheating is effected by the dynamic action of the steam in the boiler, but the loss which this action might occasion is repaired by the evaporative power of the generator, and in effect neither increases nor diminishes its efficiency. Theoretically, it is not possible for steam to do work upon a piston without becoming condensed, so that even if the full pressure were carried to the point of cut-off there would invariably be an equivalent weight of water to the amount of work performed. If, on the other hand, the steam expands without doing external work in the transmission of energy, then, since the total quantity of heat (if I may be allowed to use the analogy) remains constant, and with it the total quantity of work which it is capable of performing in expanding to a still lower pressure, the power must be exerted under a combination of two different conditions, one—as by the expansion of pure steam following the law of condensation, and the other—conforming to the laws of fixed gases while the steam remains superheated. We believe in the conservation of energy, and we must, therefore, conclude that the superheating of steam in this way by steam of a higher pressure cannot be shown to be either loss or gain. Loss of pressure by wire-drawing of the steam is a direct loss of power in the first instance, and though we are led to expect an equivalent addition of heat, it is not energy exactly, in the form which we desire. Experience would seem to teach that the less the free action of steam is interfered with during its expansion, the greater the efficiency of the system. In order that the steam line of an indicator diagram may not be unduly lowered towards the point of cut-off, a certain ratio must be observed between the rate of change of volume and the area of opening to steam. A convenient rule for the area of opening to steam is $a = \frac{A s}{10000}$ where a is the area of opening, A the area of cylinder in square inches, and s is the mean speed of the piston in feet per minute (2 stroke × revolutions per minute).

Marine engines invariably are so fitted that the distance through which the steam may be carried can be adjusted within certain limits. With special valve gears and with separate cut-off valves the range is much greater than with the common link motion. In any form of valve gear, however, the point of cut-off will have very little influence on the direction of the steam line of a diagram, because in extending the point of cut-off, or inversely in increasing the expansion, the effect is usually obtained by simply reducing the motion of the valve, thereby decreasing the area of opening to steam and the speed of the piston is nearly the same proportion.

The most interesting and instructive line of the diagram is the expansion curve. When the valve closes to steam the nature of the curve described by the indicator is subject to so many possibilities that we must be guided in our conclusions by what we already know as to the mechanical state of the engines quite as much as by the theoretical conditions of ideal expansion. In all cases, then, it is well to begin our study of this line of the diagram by a reference to that which would be traced without any interference with the action of the laws relating to the expansion of a perfect gas. It has been shown how this curve may be drawn either graphically or the points in the curve located by a simple calculation. If the ideal curve be drawn through the point of cut-off, it will be found almost invariably to fall below the line traced in the indicator. The extent of the difference between the two lines will depend on various conditions. If we know that the slide valve and piston are absolutely steam-tight, the difference between the two lines arises from the fact that during expansion a certain amount of the water of initial condensation becomes re-evaporated.

In text books, and indeed in most papers which treat of the liquefaction of steam in a cylinder, the prevailing idea seems to be alternate heating and cooling of the piston and cylinder walls, on the admission and eduction of the steam. To practical men, however, this does not seem to be a very practical view of the case. Since the alternations are so rapid and the conductivity of iron so comparatively slow, this theory can scarcely coincide with the actual state of affairs. It may be more correct to conceive of the mass of the cylinder at some temperature intermediate between those due to live and exhaust steam, while the motion of the piston itself should tend to equalize, and by its friction to elevate the mean temperature of the mass of metal. In this view of the case it is thus easier to comprehend the process of liquefaction and re-evaporation, and the extent of the action will therefore depend on the difference between the temperatures of steam of initial pressure and that due to back pressure. In other words, the greater the amount of expansion allowed in a cylinder and the fewer the alternations, the greater becomes the difference of temperatures and the larger the percentage of liquefaction and re-evaporation.

Re-evaporation in a cylinder can never exceed, and in ordinary practice seldom equals, the total condensation, for besides the condensation which arises inside the cylinder, the condensation which must take place between the boiler and the cylinder by radiation from steam pipes and connections, and that which is due to the abstraction of heat in the performance of work should also be considered. The loss of work or energy possessed by the initial steam is thus to be referred not only by the processes herein mentioned, but also to the fact that water being a better medium for the transmission of heat, the loss occasioned by radiation from the body of the cylinder is still further aggravated. The space between the ideal curve and the actual curve of the indicator diagram will, therefore, show only a certain proportion of the total loss. The variations in the expansion curve of an indicator diagram which may be traced to mechanical defects are an abnormal increase in the pressure due to a leaky slide valve, a reduction of pressure due to a defective piston, or, as may be more common, a combination of the effects of both. It is only by the aid of the ideal curve that the prevalence of those defects and their extent may be made clear. If the point of cut-off cannot be precisely

*From a paper read before the Institution of Engineers and Shipbuilders at Hong Kong.

located, a point should be selected as near to it as possible on the expansion line itself and the ideal curve drawn through it. The clearance of the cylinder and the cubic dimensions or capacity of the steam ports should in every instance be ascertained, either by calculation or by filling the spaces with a known quantity of water. The cubic contents of the space occupied by the steam when the piston is at either extremity of its stroke is reduced to the same cross-sectional area as the cylinder, and the length thus found added to the length of the stroke. For instance, suppose that the diameter of cylinder is 20 in. and the amount of water required to fill the clearance and steam-ports is 3 1-8 gallons or 1-2 cubic foot = 864 cubic inches. Then 864 ÷ area of cylinder is $\frac{864}{314.16}$ = 2 3-4 in. nearly, so that the origin of the curve must be shifted 2 3-4 in. beyond the extremity of the indicator card and on the perfect vacuum line. The length of the expansion curve may be altered to a limited extent by the method of linking up the common valve gear or by increasing the expansion with special valve gears.

In the case of an indicator diagram taken from the intermediate or the low pressure cylinder of a triple-expansion or compound engine, the nature of the steam line will depend on the points of cut-off, the volume of steam chest, the ratio of volumes of cylinders, and the relative positions of cranks. The effect of increasing the expansion by linking up is to increase the initial pressure on the piston, while the steam chest being of limited capacity, the steam line invariably falls towards the point of cut-off. The greater the capacity of the steam chest the less will be the fluctuations in the steam pressure, and if the steam ports are of ample area the more nearly parallel will the steam line be with the base or atmospheric line. The sequence of the cranks affects the steam line in the same way. For instance, if the cranks be so arranged that when the first engine begins to open to exhaust, the one next in series is just opening to steam, there will be less of a fall towards the point of cut-off. Generally speaking, the point of cut-off in the I. P. or L. P. cylinder of a triple compound engine decides the mean pressure only, while the nature and direction of the steam line depends mainly on the considerations already noticed.

The exhaust line is very seldom a cause for complaint. The position on an indicator card at which the valve opens to exhaust is determined by the difference between the external or steam lap, and the internal or exhaust lap of the valve. If those laps were equal, then the opening to steam on the one side and the opening to exhaust on the other would occur at the same position of the piston. The closing to exhaust on the one side would also take place at the moment of closing to steam on the other, but this condition will be easily seen to be opposed to the best practice, for in the case of an engine with an early and fixed cut-off the compression would become too great. In marine engines the usual plan is to have as little exhaust lap as possible, just enough to insure that the ends of the cylinder shall not communicate through the valve. But even this practice is sometimes reversed and the valve is given a small amount of negative lap (i. e., the exhaust edges of the valve do not cover the steam ports in the cylinder face when the valve is in mid-position), in order to fill that end of the cylinder in which compression is about to take place with steam of higher pressure. The opening to exhaust will, therefore, usually take place when the valve is about the middle of its travel, that is, when the valve is moving at its greatest speed. At the same moment the piston is approaching the dead center and is moving very slowly, so that it is principally due to this circumstance that the exhaust line is in most cases satisfactory.

The back pressure line depends to a great extent upon the same considerations as those which govern the steam line of the engine next in series. If the diagram be one taken from an L. P. engine exhausting to a condenser, or from any simple expansive engine, the back pressure is, as a rule, more constant, because in such a case it is independent of those conditions which determine the back pressure line of a H. P. or I. P. engine in a series. The capacity of the steam chest itself is subject to variation, for it should be remembered that the volume of the cylinder which, at the moment of opening to exhaust, must be added to the total volume, decreases as the piston returns to the opposite end of its stroke. The result is that the back pressure line of that engine is more nearly uniform than it might otherwise be owing to this contraction of the total space which the steam occupies at the instant of opening to exhaust. We have seen that the position on a diagram where the exhaust closes and the compression begins is governed both by the steam lap and by the exhaust lap of the valve. The steam lap decides the angle between crank and eccentric, and therefore the relative position of piston and valve. Exhaust lap and the position of the valve determine the position of the piston where compression begins, that is, the exhaust lap, to produce compression in a cylinder, can only modify the action of the valve, since its position is already fixed by the steam lap or expansion to be allowed in the cylinder. The point of closing to exhaust is, therefore, primarily dependent on the point of steam cut-off, and it is hastened by adding internal lap. It will follow that if by any means we alter the expansion in a cylinder, such as by linking up, we correspondingly change the compression. The nature of a compression curve follows the same laws as those under which the expansion curve is generated and is liable to the same defects. The total clearance of space occupied by the steam when the piston reaches the end of its stroke is the main factor in the determination of the compression curve when it exists. Let us suppose that the total clearance at one end of the cylinder is to be equal to 3 in. in the length of the cylinder capacity. Then, if the exhaust closes 3 in. before the end of the stroke, the space occupied by the steam at the moment of closing to exhaust is (3 + 3) equal to 6 in. in the length of the cylinder.

We will also suppose that the pressure of steam at the moment of closing to exhaust is 75 lbs. per sq. in. absolute. To find the pressure to which the steam will rise by compression we need only apply the rule we have already given, viz., $P \times V$ = a constant. so that if $P + V = 75 \times 6 = 450$ when compression begins, the pressure at the extremity of the stroke will be $\frac{150}{3}$ =

150 lbs. per sq. in. absolute according to Boyle's law, i. e., if the space be reduced by one-half the pressure is doubled. Upon this supposition we may construct the complete curve in the same way exactly as we have applied it in the construction of the ideal expansion curve. All that is necessary to be known is the volume of the steam ports and the clearance of the piston in the cylinder, the distance of the piston from end of its stroke when the valve closes to exhaust, and the absolate pressure of the steam at that moment. We thus may see that an ideal compression curve may be traced if we know beforehand the total clearance at the end of the cylinder, and conversely if the actual compression curve of a diagram is at all uniform, we may locate its origin, and thereby find approximately the total clearance in terms of the length of cylinder which gives the same cubic capacity. In Fig. 16, *AB* is the atmospheric line, *CD* is the line of perfect vacuum, drawn parallel to *AB*, and about 15 lbs. below it to the same scale as the diagram. Select two points *a* and *b* on the compression curve as far apart as possible, only making sure that they are included in the curve. Complete the parallelogram *a c b d*, by drawing the horizontal lines

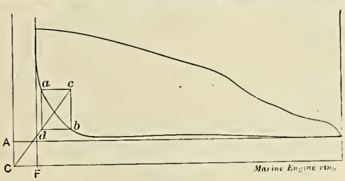


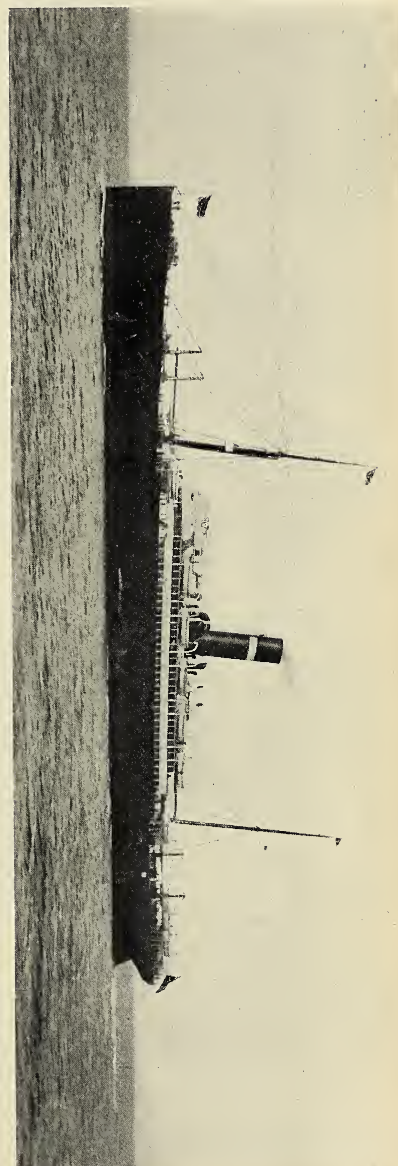
FIG. 16.

a c from *a*, *b d* from *b*, and the vertical lines *a d* from *a*, *b c* from *b*. Through *c d* draw a straight line, and produce it till it cuts the perfect vacuum line in the point *C*. Then *C* is the origin of the curve, and the length *CE*, beyond the length of cylinder *ED*, measures the total clearance in the same way that *ED* measures the cubic contents of the space swept by the piston. Measure *CE* to the same scale as *ED*. and state the terms in proportion, thus:

Total clearance: Space swept by piston :: *CE* : *ED*, or we may simply multiply the area of the piston by the length *ED*.

In those engines which have a separate cut-off valve, a too early exhaust or an excessive compression can be avoided to a greater extent, for the actual cut-off being effected by the expansion valve, the steam cut off by the main slide valve may be made to take place much later in the stroke, less steam lap is required, and consequently the effect produced by the angular advance of the eccentric, which has been shown to be mainly accountable for the position at which the exhaust closes, is proportionally modified.

A close estimate of the number of first and second class passengers who have left New York on transatlantic vessels since the beginning of May last places the number at 40,000, and the total of fares paid between $15,000,000 and $16,000,000. The great increase in the volume of travel is accounted for largely by the diminished travel last season, due to the Spanish war.



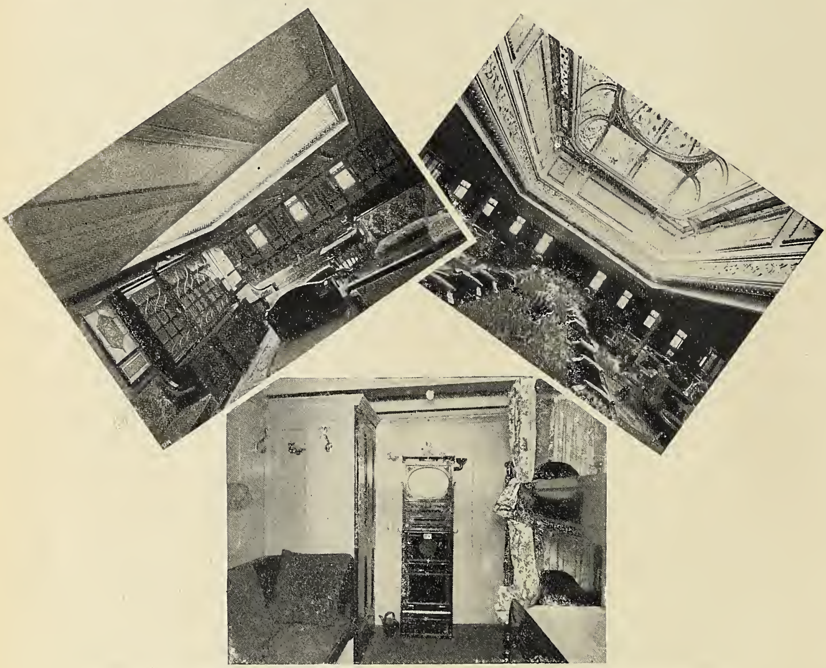
TWIN SCREW STEAMSHIP NEW ENGLAND, 12,000 TONS, ON THE BOSTON-LIVERPOOL ROUTE OF THE DOMINION LINE—FOR DESCRIPTION SEE PAGE 74.

S.S. NEW ENGLAND, A TRANSATLANTIC LINER OF THE INTERMEDIATE TYPE.

A splendid example of the modern and growing "intermediate" type of liner is the Dominion Line mail steamer *New England*, now sailing on the Boston and Liverpool route of the company. This boat, a product of the famous Harland & Wolff yard, has become very popular with the traveling public and of great interest to shipowners, so a brief description, with photographs, will be of general interest.

The dimensions of this fine vessel are: Length, 565 ft.; beam, 59 ft. 3 in., and gross register tonnage nearly 12,000 tons. She has accommodations for 500 first and second cabin passengers and for 800 in the steerage. She is in fact one of the very largest vessels afloat carrying all classes of passengers. The poop on the after section has been entirely set apart for steerage passengers. They have a dining saloon 80 ft. long and 18 ft. wide in which there is a piano, and from this room there is an inside stairway leading to a spacious smoking room on the upper deck aft.

The first cabin accommodation is luxurious. The grand saloon, which is on the upper deck, has seating capacity for 200, and is beautifully decorated in lincrusta panels with satin wood facings, and is artistically picked out and relieved with gold. Over the saloon there is a glass dome, brightly colored and emblazoned with coats of arms and heraldic devices. The library, situated on the promenade deck, is fitted up in unique style. The walls are beautifully paneled in satin wood of different shades, each panel containing a carved figure of some poet or writer, and the New England States are also represented by their richly cut coats of arms. The furniture is Chippendale and the upholstery is flowered electric-blue plush in harmony with the other decorations. The "Lounge," situated on the same deck, is forward of the grand saloon. It surrounds the saloon dome and has a deck laid in parquetry, covered with rich and costly Turkish rugs. A beautiful effect is obtained by the colored glass dome panels, which softly illuminate this resting place. There are four spacious promenade decks, each 186 ft. long and 17 ft. wide, set apart for the saloon passengers.



Library on Promenade Deck. *First-Class Cabin.—Two Berths.* *Main Dining Saloon.*

The *New England* is a twin screw ship, fitted with triple expansion balanced engines, with cylinders 30 in., 50 in. and two 58 in. by 54 in. stroke. They are of 8,700 I. H. P., and are supplied with steam, at 180 lbs. pressure, by three double-ended and three single-ended Scotch boilers. These have a total grate surface of 665 sq. ft., and burn about 180 tons of bituminous coal

per day under natural draft. In the engine department there is a very extensive installation of auxiliaries, including the various independent pumps, feed water heaters, filters and evaporators, also electric light and refrigerating machinery.

The hull construction of the vessel is very strong and conforms to the requirements of the highest class of Lloyds. She has a double bottom with a capacity

Thrust Block Recess in Engine Room.
One of the Shaft Alleys.

Standing By on Starting Platform.
Top Platform in Engine Room.

of 1,700 tons of water ballast, and has four continuous steel decks and nine water-tight bulkheads.

Steam Dredges.—Two powerful twin screw steam dredges have been built by William Simons & Co., Renfrew, Scotland, for use in North China. The vessels are fitted with dredging apparatus of the bucket type, and also with centrifugal pumps which discharge on shore through piping the dredgings raised by the buckets. On trial, when running 18 buckets a minute, 1,050 tons of loose soil were raised per hour, and when dredging in harder material at the rate of 12 buckets per minute 450 tons of soil were raised per hour. On the measured mile these vessels attain a speed of about eight knots.

METHOD OF STRENGTHENING COPPER STEAM PIPES LONGITUDINALLY.*

BY T. MESSENGER.

The question of strengthening copper steam pipes is one of considerable importance, taking into consideration the high pressures now used. In past times, when low pressures were used and lighter pipes were necessary, the longitudinal brazed seams could be more satisfactorily made by means of the carefully brazed dove-tailed lap system, as shown in Fig. 1, than is now made by the brazed lap seam without dove-tailing. The writer is of the opinion that, were it not for the much greater expense involved in making the dove-tailed lap joint in dealing with the greater thickness of the material necessary, the old system would still be preferable in making a stronger and more reliable joint.

In either case brazed seams will be undoubtedly strengthened by means of some system of bands or

*Paper read before the North east Coast Institution of Engineers and Shipbuilders, England.

straps placed round the pipes at suitable intervals, and should any defect develop in a particular part of the joint the effects of such bands will be to confine the defect locally and prevent the danger of a long rent, and possibly disastrous consequences. Several methods of strengthening pipes are in use, such as binding them

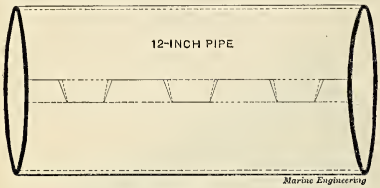


Fig. 1.

with a continuous coil of wire from end to end, placing separate bands of wire at intervals, the wire being shrunk on by heating and the ends of the wire joined by twisting them together, and occasionally hoops have been used, secured by means of lugs and bolts. The writer having had occasion to deal with pipes of considerable size, and for which it was necessary to obtain a higher factor of safety, has adopted with success the system herein described.

This consists in fitting round the pipe, as shown in Fig. 2, a series of bands of wrought iron or other suitable material, and placed at intervals of, say 6 in. apart. use of this tool enables the cotters to be gently forced into position without having to use either part or the

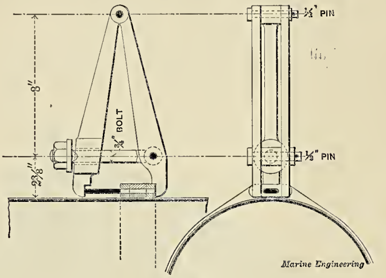


Fig. 3.

hammer for tightening up, and it can also be used for removing the cotters when necessary for repairing or testing the pipes. The bands can by this means be secured to the pipes when the latter are in place or otherwise. In strengthening pipes where bends occur the section of the band is made round, as shown in Fig. 4.

Although in new work steel or iron pipes are now being used, there are a great number of vessels having existing copper steam pipes which may require strengthening, owing to their becoming weakened by age, and in such cases these bands can be easily applied.

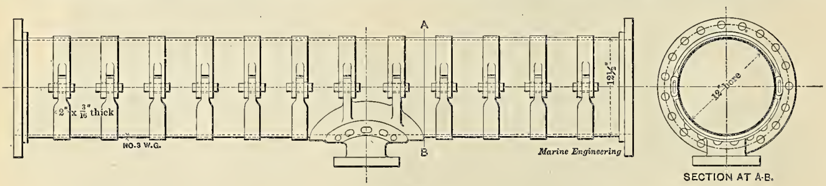


Fig. 2.

In the example shown the copper pipe was 12 in. dia. and No. 3 W.G. thick, and had been twelve years in use, subject to a working pressure of 110 lbs. per sq. in., when it began to show defects. The bands fitted were each made in halves, each half being secured to the other by means of cotton passing through single and double-eyed joints. The bands were placed 6 in. apart between centers, and the section of the flat parts of same was 2 in. by 3-16 in., and the strength of the parts at the joints and cotters was made 10 per cent in excess of other parts. The original factor of safety by Board of Trade rule was 11.3, and after fitting the bands this was increased to 15.7, or nearly 40 per cent more, which was considered sufficient in this particular case. It will be noticed, on referring to the figure, that the pipe in question has a branch, and it will be seen how conveniently such bands can be adapted and fitted around the flanges of branches, and so materially strengthen the main pipe.

The cotters used in fixing the separate halves of the bands together, on being inserted in the eyes of the single and double ends, are fixed in place by means of a special tool, Fig. 3, which has vise-like jaws. The

In the case of copper pipes the increased temperature due to the high pressure, causing a reduction in

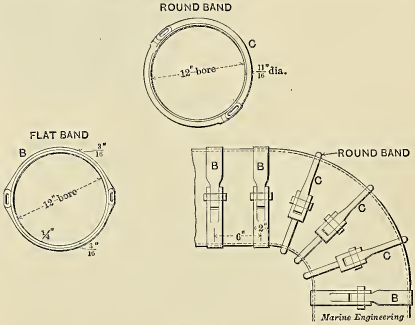


Fig. 4.

strength of the material, may render additional strengthening by such means desirable.

INSTANTANEOUS PHOTOGRAPH OF THE FAMOUS OLD GUION LINER ALASKA, TAKEN WHEN SHE WAS ENTERING THE PORT OF NEW YORK.

Memories of the great record smashing period of the eighties are recalled by the announcement that the old Guion liner *Alaska* has been sold on the Clyde to be broken up. Those who knew the ship only by reputation, alike with those who knew her from personal observation, must have a feeling of regret, strange perhaps in connection with an inanimate object, but none the less real. There is, however, something almost animal about such a ship which finds a response in any nation possessed of the racing spirit. In her day the *Alaska* was the best known vessel afloat, and her name will ever be prominent in the annals of steam navigation. She was the first ship to make the transatlantic voyage within seven days. As will be observed from an inspection of the accompanying photograph, the *Alaska* was an unusually handsome vessel, four masted, barque rigged, and with two funnels of good proportions. She did not look bulky, although for the period a large vessel, and in fact it was often said of her that "she did not look her size."

The *Alaska* was built at the Fairfield yard on the Clyde from the designs of William Pearce, who a short time before had turned out the wonderful *Arizona*, also for the Guion line. It was the success of that vessel indeed which induced the Guions to build the larger and more powerful *Alaska*. As a matter of record we give here in detail the dimensions, etc., of the *Alaska*. Length, l. w. l., 500 ft.; beam, 50 ft.; depth from main deck, 38 ft.; gross tonnage, 6,932 tons; under decks, 6,586 tons; net, 3,554 tons; displacement at load draught of 21 ft., 9,210 tons; block coefficient, .614; mid section coefficient, .904. She was fitted with three cylinder compound vertical inverted engines, with high pressure cylinder, 68 in. dia. and two low pressure cylinders 100 in. dia. and 6 ft. stroke, with cylinder ratios of 1 to 4.32. According to the then prevailing practice the high pressure cylinder was set between the two low pressure. The I. H. P. was 10,500, and on trial the *Alaska* is said to have reached a speed of 18 knots. She was fitted with nine Scotch boilers, 15 ft. dia., having six furnaces each and a total of 1,242 sq. ft. of grate surface. They were built for 100 lbs. working pressure. She was, of course, a single screw vessel with a four bladed propeller 23 ft. dia. and 34.6 ft. pitch.

The *Alaska* came out in the month of November, and after leaving Queenstown on her maiden trip she ran into a hurricane and the steam steering gear gave out and later the emergency hand gear broke down, causing a delay of ten hours. Another delay was caused on the trip by the breaking of a small steam pipe, which drove the engineers out of the engine room for a time. For some reason a full head of steam was not maintained, but in spite of this she averaged 16 knots in the trip across, and her best day's run was 402 knots. She continued doing better, and in 1882 she reduced the time of her eastward passage (New York-Queenstown) to 6 days, 18 hours and 37 minutes. The following year she cut down the westward passage (Queenstown-New York) to 6 days, 21 hours and 40 minutes, proving herself to be the then fastest steamship afloat. Her popularity was tremendous, and her sailing list during the season was always filled.

The *Alaska* had seven decks, the first or promenade deck extending the entire length and breadth of the vessel, except for the spaces at the ends occupied by the "turtle." On this deck according to the prevailing custom the boats were carried. The next deck was open at the sides and on this were the officers' quarters and accommodations for second cabin passengers. On the next or main deck the saloon accommodation was located. The dining saloon was 50 ft. wide, 64 ft. long, and had a seating capacity for 280 passengers. At the sides the ceiling was 9 ft. high, and in the center 20 ft. high. On the fourth deck the steerage passengers were berthed, and below the spaces were used for cargo. The *Alaska* had accommodation for 340 cabin, about 100 second cabin, and 1,100 steerage passengers. She was fitted with all the latest improvements of her time, including electric lights and call bells.

So successful had been the *Arizona* and the *Alaska* that the Guions decided to build another and yet larger vessel, the *Oregon*, also a product of the Fairfield yard. She came out in 1883 and successfully lowered the *Alaska's* record, but the company had already become involved in financial difficulties and the *Oregon* passed into the possession of the Cunard line.

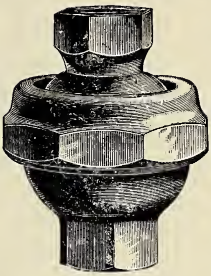
During one voyage the *Alaska* lost her rudder, but she was enabled to go ahead again by passing lines to a steamer which came up, and towing the assisting vessel instead of being towed. In this way both vessels reached New York safely. Captain George S. Murray was in command of the *Alaska*, and was a most efficient and popular officer; of his subsequent career we have no record.

After the Guion line went out of business in the early nineties the *Alaska* was laid up in the Clyde along with the *Arizona*, and we believe was not again in commission until 1896-7, when she was in the service of Spain as a transport, sailing under the name of the *Magellanes*. After a short career she was again laid up and probably did not receive any attention, as it was reported not long ago that she had nearly sunk at her moorings. In the light of present practice she was long since classed as a "coal eater." Her partner in the record smashing business, the *Arizona*, to which vessel the term "Greyhound" was first applied, is now doing fine service in the Pacific as a U. S. transport.

IMPROVED APPARATUS.

Moran Flexible Joint.

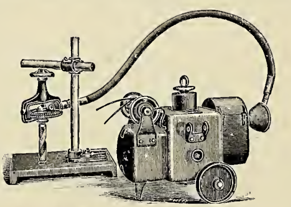
For use on steam mains, or in fact in any place aboard ship, where expansion and contraction of pipes is to be provided for, the Moran Flexible Joint is recommended by the manufacturers. The joint is very simple in construction, consisting of only three pieces, the bell or cup, the ball, and the ring for keeping the ball in position inside the bell. It is made without packing or springs and with a certain amount of looseness, and it becomes steam tight by the internal pressure bringing the spherical surfaces in contact with each other, holding them thus so long as any pressure is maintained in the pipes. The joint is manufactured also for specially high pressure work, running, so the makers say, as high as 2,000 lbs, per sq. in. The joint is manufactured by the Moran Flexible Steam Joint Company, 149 Third street, Louisville, Ky.



MORAN JOINT.

Portable Plant for Drilling.

For emergency work on ship board a specially useful tool is the combination of Stow Flexible Shaft and Multi-Speed Electric Motor. The motor is of the iron clad type, practically dust proof, and water proof, and with its case is carried on an axle and two wheels, so that it can be readily moved about. A special feature of the machine is the facility with which the speed can be changed within a wide range. This is accomplished by the gradual withdrawal or insertion of a plug of soft iron in the field magnet core, thereby varying the intensity of the field magnetism. This dispenses with



STOW PORTABLE DRILLER.

the usual more or less complicated speed regulator. The standard motors are built for 110, 220 and 500 volt circuits, but they can be built on order for any practical voltage. They are of very simple and durable construction and are guaranteed to carry, for a short time, an overload of 50 per cent. The machine can be placed in position close to the work and connected with the nearest electric ship circuit without any delay. The flexible shaft can be used to operate a

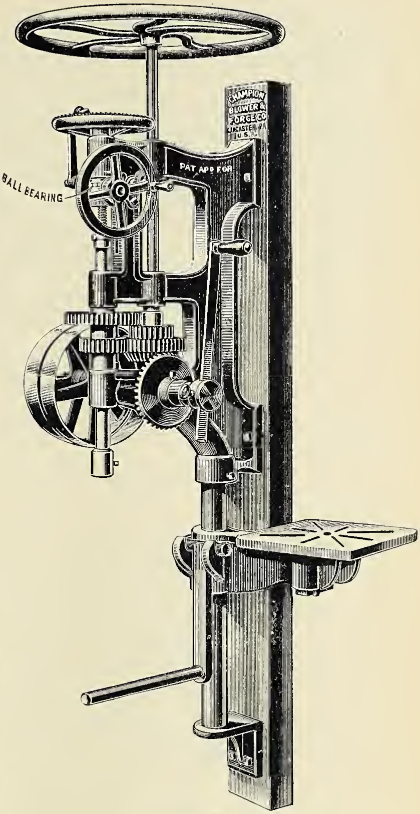
breast drill or drill press, or for the purpose of reaming or tapping holes. The sizes usually stocked cover a range for drilling holes from 1-2 in. to 2 in. dia. The combination is manufactured by the Stow Manufacturing Co., Binghamton, N. Y.

Diamond Screw Steerer.

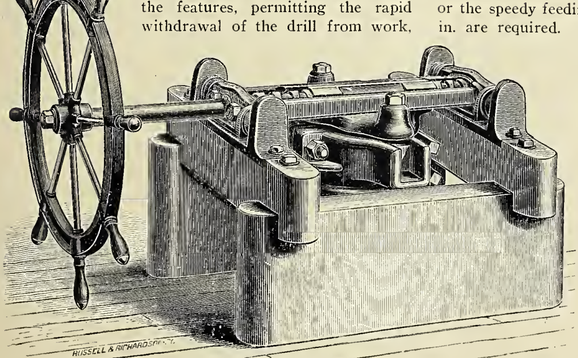
The Reed Patent Diamond Screw Steerer, manufactured by the Lockwood Manufacturing Co., East Boston, Mass., is one of the most popular steerers used on the seaboard or lakes. It is powerful, quick acting, and locks in any position. All shocks are received on rubber buffers, relieving the working parts of any sudden strain. It is simple, compact and durable, and can be taken apart and set up by anyone with ordinary tools found aboard ship. It consists of a strong steel shaft, having a right hand and left hand thread of suitable pitch, cut so that the threads cross each other, leaving a diamond shaped thread at their intersection. On each side of this shaft are long traverse nuts, a right hand thread on the port side and left hand thread on the starboard side. These nuts are guided by heavy steel bars and have on a projecting arm, steel studs fitted to a sliding block on the lower side, by ball and socket joint. These blocks slide in a wide, deep guide, planed on each side of the hoop casting on the rudder head. By this construction there is entire freedom of motion, and to cramp the gear anywhere is impossible. This steering gear can be applied to an iron rudder stock as well as to wood, and with a disconnecting attachment not shown, makes an ideal auxiliary steering gear. It is made in nine sizes to suit wood rudder heads from 4 in. to 20 in. dia. All parts are made to gauge and spare parts can be supplied promptly by the makers.

Hand and Power Drill.

A new form of post drill for hand and power use has been brought out by the Champion Blower and Forge Co., of Lancaster, Pa. This machine, as shown in the engraving, is fitted with a handle for man power and fast and loose pulleys for operation by belt. A quick return or hand feed is one of the features, permitting the rapid withdrawal of the drill from work, or the speedy feeding of the drill when sizes under 1-2 in. are required. A ball bearing is used which, it is claimed, effects a considerable reduction in the amount of power absorbed by the machine. The machine is made with double, cut, gears, so that a range of speed for light or heavy work can be secured. The machine illustrated, No. 7, drills to the center of a 19 in. circle. The spindle usually takes in a 41-64 in. straight shank, but can be bored for 1-2 in. shank if required. The speed for ordinary work is 180 revolutions per minute, and the weight of the machine complete is 325 pounds. This apparatus is specially adapted for use in the machine shop on board a steam vessel.



CHAMPION DRILL PRESS.



DIAMOND SCREW STEERER.

MARINE ENGINEERING

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SEA speeds of steamships have a special interest for American engineers, for it is in the transatlantic trade, chiefly, that this feature of steam navigation has been developed. Not exclusively so, however, and in these days of high speeds it is well to recollect the achievements of American engineers, in this direction, in the past. Leaving out of discussion vessels of the torpedo type and including only commercial ships and seagoing naval vessels, one frequently hears exaggerated statements about the actual progress in the matter of speed. Considering the item of speed alone, it is a fact that, on the contrary, there has been an increase of only about six knots in more than thirty years. In the year 1868, when the highest rate of speed on the Atlantic was about 14.5 knots (*City of Paris*, British, and *Ville de Paris*, French), B. F. Isherwood, engineer-in-chief of the United States Navy, brought out the cruiser *Wampanoag*, which attained a maximum speed of 17.5 knots, and a sustained speed of 16.75 knots at sea. During the first twenty-four hours of her trial trip she logged 405 knots. This performance was so far in advance of the then best on record that it actually caused adverse criticism, which finally resulted in the vessel being laid up and neglected. She was eventually sold, in the year 1885, for a nominal sum. Compared with the standard practice of the time this vessel was no doubt a great innovation, and her machinery equipment was so extensive that the interior arrangements were doubtless unacceptable to the sailors of the day. As a commerce destroyer, however, for which purpose she was built, her fitness cannot be questioned. A sister ship, the *Ammonoosic*, brought out about the same time, also showed a phenomenal speed, and for reasons similar to those which decided the fate of the *Wampanoag* she was allowed to fall into decay. These ships were of about 3,300 tons (old measurement) and were fitted with horizontal direct-acting geared engines with surface condensers. The speed of 17 knots was attained on a coal consumption of five and three-fourths tons of coal an hour. The extraordinary performances of these ships can be better appreciated when it is remembered that at the time the fastest ships in the British Navy were only capable of a speed of 14 knots. In fact, the performances of these two United States warships remained unequalled more than ten years, when the Guion liner *Arizona* lowered the Atlantic record. From the early eighties to the present day there has been a steady advance in speed both in merchant and naval ships, until now we have the U.S.S. *Minneapolis*, with a record of 23.073 knots; the Germans have the transatlantic liner *Kaiser Wilhelm der Grosse*, which lately maintained an average of 22.62 knots on the eastward passage; and the British have the mail steamers *Ulster*, *Munster*, *Leinster* and *Connaught*, with a daily sea speed of 23 knots. There is one very simple reason why a slight increase in hourly speed causes what might be called a disproportionate result in the success of a transatlantic liner—a reason that is sometimes lost sight of. Owing to the duration of the voyage—the great distance traveled—a small though uniform increase in hourly speed means a considerable fraction of time in the aggregate. Taking the New York-Queenstown trip as 2,900 nautical miles, this can be covered by a 20-knot boat in 6 days, 1 hour, while a boat averaging 20.5 knots will perform the passage in about 3.5 hours less time. In the case of a short sea passage, as in coast or across channel trade, while the proportionate difference would be as great, the actual difference would be so slight as to escape ordinary notice. In a 60-mile trip, for example, the difference in time of passage of two such boats would be (roughly) only five minutes. Though high sea speed has been attained in special service, it must not be supposed that the records prominently reported now and

again are indicative of the speed usual in the merchant service. In Lloyds' list there are only forty-three merchant steamships of all nationalities classed as having speeds of 20 knots and upwards, and several of these are cross-channel paddle steamers. It is not in speed, however, that the most striking advance has been made, but in the directions of efficiency and economy. The proportion of effective horse power to tons weight of machinery has grown very considerably, or looking at the displacement side of the matter, weights have been cut down about one-half. In ordinary mercantile practice to-day, we can get 9 or 10 indicated horse power per ton of machinery, while in those days 4 to 6 indicated horse power was usual. Coal consumption, measured by indicated horse power, has been more than cut in two, boats of to-day running on a consumption of 1.5 pounds of coal per indicated horse power per hour, whereas 3 to 3.5 pounds was the average 30 to 40 years ago. In the future, too, it is not unlikely that greater progress will be made in these directions than in speed, though, of course, the latter in great measure depends upon the former. Engineering considerations alone, however, do not govern, for they are secondary to commercial considerations in mercantile marine construction, which is in fact a most elaborate series of compromises.

IN another place in this issue we publish the report made by Captain Frederick Watkins of the steamship *Paris* to the U.S. Board of Supervising Inspectors at New York, in which he takes unto himself the entire blame for the mishap. Upon this statement the Board, after deliberation, has found Capt. Watkins guilty of negligence and suspended his license as master for a period of two years. This sentence seems to be a severe one judging from the published record of the proceedings, but doubtless the board acted upon its best information and belief. No lives were lost in the mishap, nor indeed was any person injured, and this might be advanced as a reason for leniency, taking account also of the splendid previous record of the unfortunate commander. If we are not mistaken, no heavier sentence was imposed upon Capt. Williams, of the liner *Atlantic*, who lost his vessel and 500 of those on board on the coast of Nova Scotia in March 1873. It is very probable, however, that Capt. Watkins will feel the loss of his ship far more keenly than the temporary loss of his certificate. It is often said of transatlantic captains that it is only a question of time when they will get into trouble at sea, which although not true, is a correct indication of the hazardous nature of their occupation. Since the mishap occurred there has been a good deal said about the necessity for some means of checking the calculations made by the captain in setting the ship's course. Theoretically this would work all right, but practically it might not. The captain of a ship is and must be responsible for the safety of the ship and all it contains, and there can be no division of duties without a similar division of responsibilities. If he is not competent to properly set the course of his ship he is not competent to be in command, no matter what may be the reason for his condition of incompetency. His attention and responsibilities alike must be undivided. It is related of a Cunard captain that he asked and obtained permission for his wife to accompany him on a trip across the Atlantic, but when he got down to his ship to take her out he found that he was entered as a passenger only and that another captain had been given command for that trip. Now that the *Paris* is safe in port again it is very probable that she will be put in condition for a prolonged period of usefulness. With a newer and more economical machinery equipment she would be really an improved vessel, and the staunchness of her construction, which has again been demonstrated in this mishap, will be recognized by the discriminating traveler.

SHIPBUILDING and ship owning statistics compiled by Lloyds show the total merchant tonnage of the British Empire to be nearly 14,000,000 tons, of which 11,719,247 tons is steam tonnage. The second place is held by the United States with 2,465,387 total tonnage, and Germany is a close third with 2,453,334 tons. The other maritime nations follow at a considerable distance; from Norway with 1,694,230 tons to Portugal with only a little over 100,000 tons. Spain is credited with 608,885 tons. In ships with a tonnage of 10,000 and upwards, Germany takes the lead, having twenty steamships in this class, and the United Kingdom comes next with nine only. Taking account of vessels of 5,000 tons and upwards, however, the United Kingdom leads with a total of two hundred and fifty, and Germany second with fifty. The United States has now only three.

MARINE BREAKDOWNS AND LOSSES.

LOSS AND SUBSEQUENT RECOVERY OF THE AMERICAN LINE STEAMSHIP PARIS.

After lying on the Manacle rocks for more than fifty days, the American Line steamer *Paris* was safely floated by the salvors on July 11, and was later towed into Falmouth Harbor. It was on Sunday morning, May 21, that this fine vessel went ashore while westbound from Southampton, via Cherbourg, France, to New York. She had 386 passengers on board and was proceeding at the usual rate of speed, when, without warning, she went hard on an outlying ridge of the Manacle rocks, off Lowlands Point, on the coast of Cornwall. The passengers were aroused and taken ashore in boats and aboard tugs which came up.

Following the disaster there was naturally much conjecture as to how it could have occurred. When she struck the *Paris* was within 150 yards of the shore and not half a mile from the spot where the Atlantic Transport liner *Mohegan* was wrecked on the night of October 14, 1898. Now, however, the real cause of the loss of the vessel has been made known by her late commander, Captain Frederick Watkins, in his report to the United States Board of Steamboat Inspectors at New York. Captain Watkins' report reads as follows:

I, Frederick Watkins, master of the American line steamship *Paris* of New York, of 10,669 tons register, make oath and say as follows: I was the master of the said steamship *Paris* when she left Southampton at noon of the 20th of May last with passengers, mails and general cargo, bound for New York via Cherbourg, and at 5.21 P. M. of the same day she arrived at Cherbourg. Having taken on board forty-five further passengers and their baggage, we sailed for New York at 5.52 P. M. At 6.38 P. M. Cape La Hague was abeam, and at 7.35 P. M. the Casquets Lighthouse was abeam. At 1.19 A. M. of the 21st of May land was suddenly seen ahead and reported. The helm was immediately put hard to starboard and the port engine was put full speed astern, but directly afterward the vessel struck on the rocks, which proved to be about a cable's length from the beach. It was then discovered to be thick over the land, although there was no fog to sea. St. Anthony's Light, which had not previously been seen, appeared bright and clear about fifteen minutes after the vessel struck. We reversed the engines full speed, but the vessel remained fast, and we then fired distress signals and swung out the boats. Assistance arrived and shortly after daylight the passengers, mails and baggage were sent ashore to Falmouth.

At daylight we ascertained the ship's position by cross bearings—St. Anthony's Light bearing N. E. by N., the buoy off the Manacles Rock E. by N. ¼ N. During the day the vessel began to make water in various compartments, and such water has increased until it is in every compartment. Practically the whole of the cargo was discharged, a large portion undamaged, and efforts by the underwriters and owners have been made at great expense to get the vessel off, but she is still on the rocks and is full of water fore and aft. No lives were lost or any personal injury caused by the accident.

I regret to say that the casualty was owing to an unaccountable error on my part. It is about 131 miles from Cape La Hague to the Lizard, and the run between these points would, I calculated, occupy six hours and fifty-four minutes. Unfortunately I reckoned the time on this basis for coming up with the Lizard from 7.35 P. M., when abeam of the Casquets, instead of from 6.38 P. M., when abeam of Cape La Hague, and the vessel was thus really eighteen miles ahead of the position I was acting upon. In addition the thick weather over the land had obscured the Lizard lights.

I attribute the stranding to the above cause and take upon myself full responsibility for it. I have followed the sea as my profession since the year 1851, and have held a British master's certificate since the year 1866 and an American master's certificate since the year 1893, in which year I became an American citizen. I entered the service of the Inman Steamship Company in the year 1863, and after serving as officer in various grades I was promoted to be master in 1867, and have since 1876 been continuously master in command in the Inman and International and American line passenger and mail steamers, and have in that capacity crossed the Atlantic nearly 500 times. I was, during the war between the United States and Spain, the navigating officer of the United States cruiser *Yale*, holding a commission as Commander in the United States Navy, and on the termination of the war I received honorable discharge with the thanks of the Government.

I have thought it right to place these particulars before you in the hope that you will take into consideration a long responsible seafaring career, during which I believe I have throughout held the perfect confidence of my employers. The accident was not due to any want of thought or anxiety about my vessel or her safety, but arose purely from the mistake I made in making my calculation above described. I should add that I can only speak in terms of the highest praise of the discipline which under trying circumstances was admirably sustained by my officers and crew.

After consideration of this report the Board of Inspectors, consisting of Peter C. Petrie and Thomas H. Barrett, decided to suspend Captain Watkins' license for a period of two years. Their finding reads:

We have the honor to report that we have carefully read over the report made by Capt. Watkins, late commander of the steamship *Paris* when she was stranded on the English coast, between the Lizard and the Manacles, on May 21, 1899, at about 1.19 A. M., in which Capt. Watkins takes the entire responsibility of the disaster upon himself in making a mistake in the time when he passed the Casquets and thereby overrunning his distance.

We find that the report is very meager in details, inasmuch as he merely states that he made a mistake in taking his departure from Cape La Hague at 7.38, when he was actually abreast of the Casquets at that time, a distance of about 16½ miles. This, of course, would put him 16½ miles ahead of his reckoning, but would not account for his being set in to the northward of his course some seven miles, allowing his intention pass the Lizard at a distance of three miles. As Capt. Watkins does not make any mention of making any allowance for tide, we are of the opinion that he had not taken that matter into consideration, whereas when he approached the English coast he must have encountered the flood tide on his port bow, setting him in toward the land. In addition to this he makes no mention of having used his lead, and he only discovers it was thick over the land when the ship is ashore.

Giving all due consideration to these matters, we are of the opinion that Capt. Watkins has not acted with the necessary care and attention requisite in the navigation of his vessel which a master should have used, and we therefore suspend his license as master of ocean steamers for a period of two years, as per authority conferred upon us by section 4,439 of the Revised Statutes of the United States.

A day or two after the passengers were landed a meeting was called, at which their thanks was expressed to the American Line for the courtesy and consideration with which they had been treated in these distressing circumstances. A number were given passage in the westbound German vessels, while others preferred to wait for the next outgoing American liner.

Following the mishap persistent efforts were made to get the *Paris* off the rocks, but it became apparent that extensive operations would be necessary if the vessel was to be saved. She was accordingly declared a total loss and abandoned to the Underwriters, who made an agreement with the salvors on the basis of "no cure, no pay." Systematic works was then begun, including the blasting away of the rock, and the floating of the great ship occurred rather unexpectedly. While an effort was

TWIN SCREW TRANSATLANTIC LINER PARIS SAILING UNDER THE HOUSEFLAG OF THE AMERICAN LINE—EMPLOYED AS AN AUXILIARY CRUISER (U. S. S. YALE) DURING THE SPANISH WAR.

being made to swing her stern around, so as to facilitate driving operations, she slid off the rocks into water sufficient to float her. Examinations showed that the holes in her bottom were not as extensive as had been supposed, and with the aid of the salvage pumps the vessel was easily kept afloat.

The *Paris,* as shown in the picture drawn by our artist, is a three-masted, three-funneled steamer, with a clipper bow. She is a twin-screw vessel, in dimensions: Length, 560 ft.; beam, 63.2 ft.; depth, 42 ft.; gross tonnage, 10,795 tons. She was built at Clydebank, Scotland, in 1888 to lower the Atlantic record, which she was successful in doing. Her 24 hours' record is 530 knots. The propelling engines are triple expansion, with cylinders 45 in., 71 in., and 113 in. dia , and 60 in. stroke, and at 90 revolutions they indicate 20,000 horse power. She has nine boilers, built for a working pressure of 150 lbs., and her

coal consumption is over 300 tons a day. She has accommodations for 540 first cabin and 200 second cabin passengers besides those in the steerage.

This is the second time in the history of the *Paris* that she has come safely out of threatened disaster. On her occurred what was undoubtedly the most disastrous machinery mishap in the history of transatlantic navigation. On March 25, 1890, while bound east, with about 1,000 passengers on board, the starboard tail shaft broke and the immense engines immediately raced and knocked themselves to pieces. The condenser connections at the side were torn away, and the engine room was immediately filled by the inrush of water. Flying fragments of the starboard engine had pierced the longitudinal bulkhead between the engine rooms, and the port engine compartment was in consequence filled also. There was a rough sea on at the time, and the big liner was tossed about helplessly. Three days later the steamship *Aldershot* was sighted, and took the *Paris* in tow for Queenstown, about 170 miles distant. There the sea connections on the starboard side were plugged, and the vessel, having been pumped out, proceeded under her own steam, with the port engines working, to Liverpool. The wreck of the engine was complete, or, in other words, a ten thousand horse-power engine was in scrap. The damage was estimated at $500,000, and a further sum of $37,500 was awarded the *Aldershot* for towage. Four years later the rudder of the *Paris* became disabled while on a westward trip, and she put back in Queenstown steering with the twin-screws.

The *Paris* was built for and operated by the Inman Line, and until that line was absorbed by the American corporation now known as the International Navigation Company, and more familiarly styled the American Line. She was admitted to American registry in 1893 by special act of Congress. The International Navigation Co. is now building several vessels, particulars of which are given on page 48 of this issue.

Mishaps to Naval Vessels.—Several serious mishaps on vessels of the torpedo-boat type have been reported recently from abroad. Early last month, while a destroyer built at a Sunderland yard was on trial, a steam pipe burst and eight men were more or less seriously scalded. An accident on H. M. torpedo-boat destroyer *Bullfinch,* which occurred on July 21, is reported by cable to have killed nine and injured four of those on board. The vessel was running in the Solent at high speed when a connecting rod in the starboard engine is said to have broken, and a smash-up of the engine followed. Live steam from the main pipe then filled the engine room. The *Bullfinch* is a 30-knot destroyer built by Earle's Shipbuilding Co., of Hull, England. She is a twin-screw vessel, fitted with engines of 5,800 I. H. P. and Yarrow boilers. Later another cable report was received here from Pola, Austria, briefly stating that "a boiler explosion" occurred on board the Austrian torpedo-boat *Adler* in the Adriatic Sea, killing a lieutenant and four of the crew. The *Adler* is one of the earlier first-class torpedo-boats, having been built by Yarrow, London, in 1885. She is a single-screw vessel, 135 ft. long, and has a displacement of 95 tons. Her indicated horse power is 900 and speed 22.4 knots.

CORRESPONDENCE DEPARTMENT.

Editor of Marine Engineering:

I quote the following from Mr. Leavenworth's explanation of Negative Slip, Marine Engineering for March, page 3:

> "The question is then simply, under what circumstances might we expect an apparent slip of zero or negative value? Remembering the relation between these quantities as expressed in (2) it may be readily seen that this will be the case when the true slip is equal to or less than the wake."

Suppose that the true slip could be "less than wake." The velocity of the water sternward from the wheel cannot be greater than the true slip, and, therefore, if this slip be less than the wake we would have that portion of the wake that is sent sternward by the wheel going in reality forward with respect to the still water or the bottom, and we would have the remarkable result of the steamer making use of the water to *push* against and yet not pushing any sternward, but on the contrary, *pulling* water actually along with it.

It, of course, can be absolutely proved that water cannot leave the wheel with a velocity greater than the true slip, but it is so nearly self evident that unless it is disputed we will not take up your space with the proof.

Hence the true slip can never be "equal to or less than the wake," and the explanation given by Mr. Leavenworth only explains this "abstruse subject" by assuming an impossibility. G. B. Mitchell.

Reply.

In reply to Mr. Mitchell's observations I would say that the references to negative slip in the article referred to were based on the treatment more particularly presented to the engineering public by *S. W. Barnaby,* in the *Proceedings of the Institution of Civil Engineers* (*English*), Vol. CII, p. 74, while that in turn was based on a paper by *R. E. Froude,* in the *Transactions of the Institute of Naval Architects,* Vol. XXX, p. 390. A complete discussion of the question would have been entirely out of place in the article to which Mr. Mitchell refers, and it is equally so here. A study of these papers will, however, perhaps serve to show the matter from another point of view.

Briefly, the very thing which Mr. Mitchell considers as a self-evident impossibility, that which is considered entirely unworthy of further notice, is the very thing which is considered as occurring. Mr. Mitchell states that it is well known and self-evident that the water cannot leave the propeller with a velocity greater than the true slip. By *velocity* presumably *acceleration* is intended, and it is with this point that Mr. Froude's paper has to deal. It is shown that in all ordinary propellers a part of the acceleration is produced forward of the blades by the action of a defect of pressure, a part while passing through between the blades, and a part aft of the blades by the action of an excess of pressure in the race. Probably thinking of the old and familiar proposition in text-books on hydraulics relating to the impulse of a jet of water on a vane, Mr. Mitchell considers only the acceleration produced at the propeller itself. This is, of course, less than the true slip of the propeller relative to the water through which it is passing, but the accelera-

tion produced at the propeller is in reality only a small part of the total amount. Of this amount somewhat more than one-half is produced forward of the propeller, a small amount in passing through between the blades, and the remainder aft of the propeller in the race. As Mr. Mitchell will find, on examination of the problem, the behavior of a propeller in a continuous and indefinite stream of water is very different from that of an ideal vane with a jet of water impinging upon it. In spite of all the study on the point, however, the complete solution to the problem of how much acceleration in any given case will be produced ahead of the wheel, how much in the wheel, how much aft, and how much altogether, has not been found, and until it has the complete examination of the question will be hardly possible in a satisfactory manner.

In my opinion, a very important influence is also rendered by the rounded backs of the blades, to which reference was likewise made in the same article referred to by Mr. Mitchell. This point was not further developed because complete experimental data does not exist on which to base a useful discussion. Enough does exist, however, to show that the influence of the back is such (particularly at small slips) as to increase the value of the acceleration, as resulting from the true propeller slip given by a measurement of pitch on the driving face. It is due to this influence that a positive thrust is obtained for a zero true slip measured from the driving face, as shown by diagrams 1 and 2 in the article referred to.

In the meantime science awaits a more comprehensive theory of the screw-propeller, and if Mr. Mitchell can furnish this he will do the cause of scientific marine engineering most valuable service; but for this end something is required beyond destructive criticism, and the erroneous assumption of "nearly self-evident" propositions.

EDMUND LEAVENWORTH.

American Shipbuilding Returns.

In advance of the publication of the annual report of the United States Commissioner of Navigation a summary covering the statistical portion of the report has been issued as follows:

The total output of American shipyards for the last fiscal year has been the largest of any year for the last quarter of a century, except 1891, when 1,384 vessels of 369,302 gross tons were built and documented in the United States. During the past fiscal year the construction of merchant vessels, officially returned, has consisted of 1,429 vessels of 320,876 tons. Besides these, twenty-two vessels of foreign construction, aggregating 30,181 gross tons, have been admitted to American registry, of which ten were prizes captured during the war with Spain; four were steamships, aggregating 12,126 tons, admitted by special acts of Congress, and the remainder wrecked vessels, repaired in American shipyards. It is also reported from Manila that since last August 141 vessels have been transferred from the hands of the Spanish, German and British subjects to Americans, indicating the confidence of the business men of Manila in the American Government. The tonnage of these vessels has not yet been reported, and the transfer does not carry with it all the rights of American registry. Had the Senate passed the House bill for the registry of Hawaiian vessels the total additions to our merchant fleet during the year would have reached nearly 400,000 tons. Our largest annual production was in 1855, when 2,027 vessels of 583,450 tons were built and documented.

During 1898 Great Britain built 1,549 vessels of 1,399,116 tons. The difference in the kind of vessels built is roughly disclosed by the average size, our construction averaging only about 225 tons, while the British averages 900 tons. Nearly all our new tonnage is built to navigate in the coasting trade reserved to American vessels. The only steamships built directly for the foreign trade were the *Havana* and *Mexico*, of the New York and Cuba Mail, and the four Admiral steamships for Cuba and Jamaica, aggregating 19,750 tons, which were built under the postal subsidy act. In anticipation of legislation at the coming session, however, construction has begun or been contracted for on about 100,000 tons of steel steamships for foreign trade and trade with Hawaii and Porto Rico, involving an expenditure of about $15,000,000.

For the first time in our history, on June 30 the total tonnage of our steam vessels, when tabulated, will exceed the total of all other kinds of documented vessels. During the year, however, 460 sailing vessels of 96,458 tons have been built, compared with 426 of 42,502 tons for the previous year, while the steam vessels built number 478 of 167,851 tons, compared with 448 of 110,128 tons for the previous year.

In certain trades our large sailing vessels endeavor to compete with foreign cargo steamships, and will doubtless continue to do so, at all events until the construction of the Nicaragua Canal. The most notable vessel is doubtless the *John Smoaton*, a steel schooner of 5,049 gross tons, built at West Superior, Wis., probably the largest fore-and-aft vessel ever built. The largest seagoing sailing vessel built in Europe in 1898 was the *Ernest Siegfried*, of Havre, 3,214 tons.

For the first time in our history, steel has become the principal material in our annual construction of rigged vessels, the steel tonnage for the year being 133,991 tons, wood 130,309 tons. Iron has ceased to be a ship-building material, only one vessel of nine tons having been built of iron. During 1898, in Great Britain, 99 per cent, or practically the whole construction except small fishing vessels, was of steel.

The additions to our sea-going fleet, including 30,181 tons foreign built referred to, were 166 vessels of 155,987 tons, divided into 50 steam vessels of 75,289 tons, 74 schooners of 62,906 tons, 10 square-rigged vessels of 12,428 tons, and 32 yachts of 5,364 tons, including the new cup defender. The square-rigged vessels are mainly for the foreign trade, and the schooners for coasting purposes or the trade with the British provinces and the West Indies. There were built 491 unrigged vessels, barges and canal-boats for Canadian or Interstate trade, aggregating 56,567 tons. Excluding these, the greatest increase has been on the Atlantic coast, the tonnage of rigged vessels built rising from 51,136 tons in 1898 to 134,352 tons for the past year, while on the Pacific there has been a decrease from 44,896 tons to 32,412 tons. The output of rigged vessels on the great lakes was 81,390 tons, compared with 45,211 during the fiscal year 1898.

EDUCATIONAL DEPARTMENT.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XIX.

BY WM. BAXTER, JR.

AMMETERS AND VOLTMETERS.

An ammeter is an instrument that is so constructed that it indicates the strength of the current that flows through it; that is, it indicates the number of amperes. A voltmeter is an instrument that indicates the e.mf. or electrical pressure of the current that flows through it; that is, it indicates the number of volts. Both types of instruments are constructed upon the same principles, and only differ from each other in the size of wire wound upon them. There are several ways in which these instruments can be made, but the most common arrangements depend upon the action of a permanent magnet upon an electric current, or upon the action of one current upon another, or upon the action of a current upon a mass of iron. The first type can be explained by the aid of Fig. 107. In this figure, *M* represents a permanent magnet. A permanent magnet is made of hardened steel, and is called permanent because it retains its magnetism. The letter *C* represents a coil of wire, through which the current to be measured is passed. This coil is mounted so as to swing freely, and with as little friction as possible. The indicator arm *B* is mounted central with the shaft upon which the coil is secured, and moves with it so that its position with reference to the scale *S* depends upon the position of coil *C*. When there is no current passing through the coil it has no tendency to rotate, but as soon as it is traversed by a current it becomes surrounded by magnetic lines of force, and these tend to set themselves in line with those of the magnet. The lines of force of the magnet run across from pole *P* to pole *N*, and the lines of the coil run parallel with its axis; that is, in the direction of arrow *d*. The lower side of the coil, therefore, tends to swing toward pole *N*. The motion of *C* is resisted by a spring, and sometimes by a weight, although the former arrangement is the best, and the only one that can be used with an instrument that is intended to act in any position. The force with which the coil is pulled around in the direction of arrow *a* will depend upon the strength of the current passing through it, and as the spring that resists its movement will offer a greater resistance the further it is twisted around, it follows that by properly proportioning the strength of the spring and the size of the coil, the indicator can be made to move over the scale in a manner that is proportional to the strength of the current. If the instrument is to be an ammeter, and to indicate small currents, say from 50 amperes down to zero, then the resistance of the spring is made comparatively light, or the coil is provided with several turns, the result in either case being that the fifty amperes will twist the coil around until the indicator points to the end of the scale. The same instrument can be made to indicate 500 amperes by making the resisting spring ten times as strong, or by winding the coil with only one-tenth the number of turns. The last plan is that generally followed, as on account of the greater current it is necessary to increase the size of the wire so that it may not become too hot.

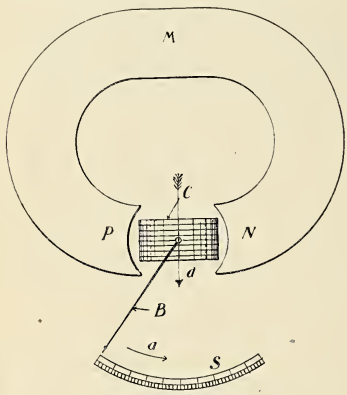


FIG 107.

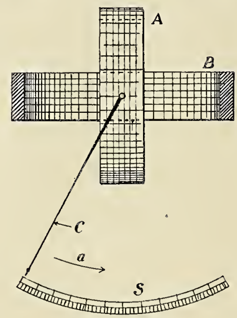


FIG. 108.

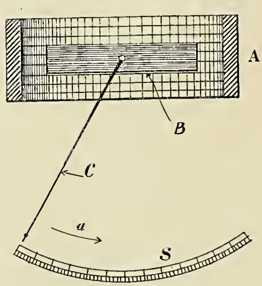


FIG. 109.

If an ammeter is intended to measure small currents, the whole current is passed through coil *C*, but when it is intended for currents of several hundred amperes, a shunt coil is provided and a definite portion of the

current is passed through coil C, the remainder passing through the shunt coil. The object of this is to avoid using large wire upon the movable part of the instrument, as it would then become necessary to provide substantial sliding contacts through which the current could pass to the coil, and the friction of these would render the instrument very torpid in its action.

When an ammeter is made with a shunt coil, the portion of the whole current that passes through the C coil is anywhere from 10 per cent down to a fraction of 1 per cent, the percentage decreasing as the capacity of the instrument is increased.

If an instrument is intended to be an ammeter, its coils are placed in series with the main line, and are, therefore, wound of comparatively large wire and a small number of turns. If the instrument is to be a voltmeter, it is connected in the circuit in parallel with the main line; that is, one end of its C coil is connected with one side of the line and the other with the other side. For example, if we desire to measure the voltage of the current delivered by a generator, we connect one terminal of the voltmeter to one of the brushes and the other terminal to the other brush. Under these conditions, the full force of the generator acts to drive a current through the voltmeter coil. Now, it is not permissible to send a strong current through the instrument, because all the current that passes through it is just so much energy lost, and, in addition, unless the instrument were made of very large size, it would become very hot. To avoid these difficulties, the coil of a voltmeter is made of very fine wire and consists of many thousand turns.

Fig. 108 shows the type of instruments in which the attraction between two currents is used to impart motion to the needle. In this arrangement there are two coils, A and B, set at right angles to each other. The coil B is stationary, and A is free to rotate, its movement in the direction of arrow a being produced by the action of the current, this movement being resisted by the tension of a spring, as in Fig. 107. The current to be measured passes through both the coils, and thus develops magnetic lines of force around each. These lines tend to place themselves in line, that is, parallel with each other; therefore, a twisting force is exerted upon coil A, and this force increases as the current strength increases.

As in the case of Fig. 107, the coil A can be made to move over its entire range with a weak or a strong current by simply proportioning the coils and the resisting spring properly in each case.

Fig. 109 illustrates the type of instruments in which the movement of the indicating arm is effected by the action of the lines of force developed by a coil upon a bar of iron placed within it. In this diagram A is the wire coil and B is the bar of soft iron. When there is no current passing through A, the bar B has no tendency to move, but when a current passes through A, a rotative force is at once developed, and B tends to move into a position parallel with the axis of the coil. If B is held directly at right angles to the axis of the coil, when there is no current flowing, upon the passage of a current it may start to swing around in either direction, as its only object is to get into a position parallel with the axis of the coil, regardless of which end goes up or down. To prevent this, all that is necessary is to set B with the left side a trifle lower than the right, then the swing will always be in the same direction. The case is like that of a crank that is placed upon the dead center; if we push against it, it is as likely to move in one direction as the other, but if the crank is slightly off the center, when we push against it, it can only move in one direction.

The bar B can be placed directly at right angles to the axis of the coil, providing it is made of steel and is hardened, but then it becomes a permanent magnet,

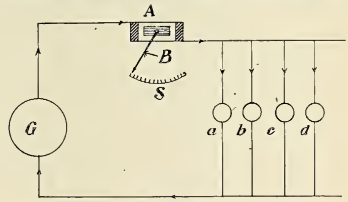


FIG. 110.

and the construction would simply be a modification of Fig. 107, in which the magnet would be placed within the coil instead of outside of it.

The movement of the bar B can be resisted by a spring, as in the previous types, or by a weight. With this construction the weight is quite commonly used, as then the bar can be arranged to swing with the greatest freedom. In the other arrangements in which a moving coil is used, it is necessary to provide means whereby the current may be conveyed to and from the coil without hindering its free movement, and the best way to do this is to use the springs, that oppose the movement, to carry the current. This can be accomplished by using springs of the clock type and placing one at each end of the shaft upon which the coil swings.

The difference between the action of an ammeter and a voltmeter can be explained clearly by means of the

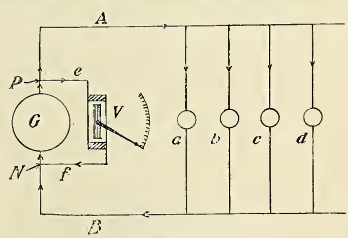


FIG. 111.

diagrams Figs. 110 and 111. The first illustrates an ammeter, and the second a voltmeter. In the first diagram, A represents the ammeter, and G represents a generator which furnished the current to operate the lamps *abcd*. As will be noticed, all the current delivered by the generator has to pass through the ammeter before it can reach the lamps; hence, if only one lamp is in use, the current passing through the instrument will be one-quarter as much as it would be if all the lamps were in operation.

In Fig. 111 V represents the voltmeter and G the generator, while A and B are the two sides of the main line, and *abcd* are the lamps. The current that passes through the voltmeter is diverted from the main line at the point P and returns to it at N, but these are the terminals of the generator. Now, so long as the pressure between the points P and N remains unchanged, just so long will the current passing through the voltmeter be constant, hence, as the pull will not change, the pointer will remain stationary. If the pressure, or difference of potential, as it is called, between P and N increases, the current passing through the voltmeter will increase, and the indicator will move further up, indicating a higher voltage, but if the difference of potential between P and N drops, the current passing through the voltmeter will reduce and the indicator will move downward, indicating a lower voltage. Since the strength of the current that passes through the voltmeter is directly proportional to the pressure between P and N, it follows that it is not influenced, in any way, by the amount of current that passes to the line wires A and B, hence the instrument will measure the voltage only and will not be affected by the rise and fall of current strength in the main circuit.

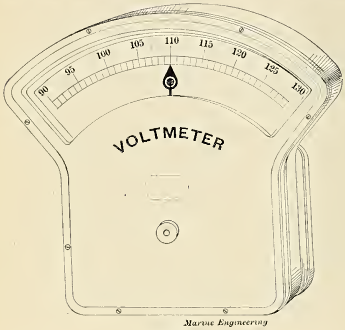


FIG. 112.

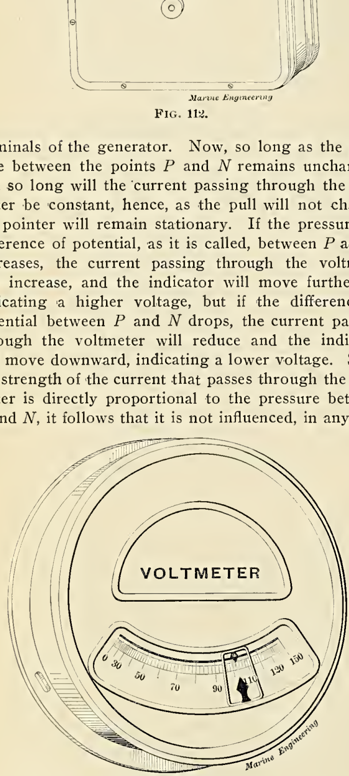


FIG. 114.

From Figs. 112-114 the form of commercial instruments can be understood, but it may be mentioned that these are only two of many designs. Fig. 113 shows the manner in which the springs that resist the movement of the coil are arranged in the instrument shown in Fig. 112. This illustration shows the instrument with a portion broken away so as to give a full view of the interior. The drum seen in the center is a core made of soft iron, and upon this is mounted the coil which can be seen with its side running parallel with the axis of the core. The spiral springs at top and bottom not only resist the movement of the drum and its coil, but also serve to form the connection between the ends of the coil and the stationary parts of the instrument; thus the current is conveyed to and from the coil without introducing the friction of sliding contacts.

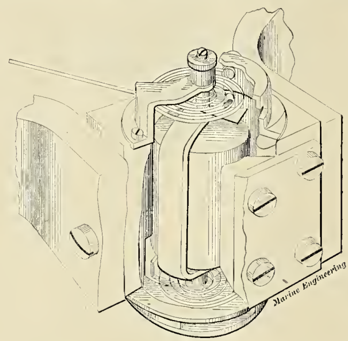


FIG. 113.

S. S. CHESTER W. CHAPIN.—At the yard of the Marylany Steel Company, Sparrow's Point, Md., the fine new steamboat *Chester W. Chapin,* for the New Haven Steamboat Company, was launched July 11. The new vessel will be practically a duplicate of the famous Sound steamer *Richard Peck,* but will have rather more cabin accommodation than that vessel. Her dimensions are: Length, l. w. l., 310 ft.; breadth, over guards, 64 ft.; depth, 17 ft. 2 in. She will have twin screws, driven by triple expansion engines, with cylinders 24 in., 38 in. and 60 in. dia., and 30 in. stroke. These will be furnished with steam by six Scotch boilers, 13 ft. dia. and 11 1-2 ft. long, built for 160 lbs. working pressure. A speed of about 21 miles an hour is looked for. The new vessel will be equipped with every modern device for the comfort and safety of the passengers. Special trains conveyed guests from New York, Philadelphia, Wilmington and Baltimore to Sparrow's Point, where they were hospitably entertained by the Maryland Steel Company. The little daughter of Superintendent D. A. Geraty, of the steamboat company, christened the vessel, which slid into the water with remarkable ease. After the launch the visitors spent some time looking over the marine department of the immense plant of the builders, and they carried away many favorable impressions. Other work in the yard includes two large freight steamers and three torpedo-boat destroyers.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—We would like to get your opinion upon a method of propulsion which we have tried. We built a boat 70 ft. long and of about 25 tons burden as an experiment. Our wheels are of different construction from the ordinary propeller. They are made of bronze, with two or more blades, and are applicable to either bow or stern without changing the forms. We run on one shaft, which pierces the boat from stem to stern. Running the stern wheel by itself we easily make, say 10 miles per hour, and this is the case with the bow wheel, also running alone. But when we combine both together our speed is only very slightly increased—why is it that when they are operated together we do not get a marked increase of speed? We lately tried a special wheel of the usual form, 38 in. dia., at the stern in conjunction with our own 22 in. wheel at the bow, but got only about the same result. What is your opinion of the value of such a wheel at the bow? Our boat handles beautifully with either of the new wheels, backing or going ahead with equal facility, and in backing it seems to exert a force far in excess of the old method.

C. H. A.

A.—Without more definite information regarding the details of your arrangement and the results of your trials, it is impossible to give any extended discussion of the questions you ask. In the first place, however, you should remember that it is the engine and boiler which really drive your boat, and not the propeller. The latter is merely an agent in applying the power developed by the former. Now, it is quite possible that either of your propellers singly is sufficient to absorb and apply the power developed by your engine and boiler, while both together can do no more; so that you get about the same speed whether you have one or the other, or both, the only differences being those due to the differences in the efficiency of the arrangement; or in other words, in the fraction of the total power developed which is usefully applied. Again, supposing even that the engine and boiler are capable of supplying the full power required for the two propellers working at the same efficiency as the one alone. Then twice the power will be applied. This, however, will by no means give twice the speed. If the speed with one propeller was 10 miles, the speed with two would not be 20 miles, but only about 12.5 miles. This is because the speed increases by no means as fast as the power, but rather about as the cube root of the power. To get a speed of say, 16 miles, which you may perhaps have felt like expecting, would require about four times the power that 10 miles would, and it is very certain that your wheels could not efficiently absorb this, even if the engine and boiler could furnish it.

In regard to the general proposition of fitting a propeller at the bow, it may be said that hitherto such attempts have been failures from the economic standpoint. The speed developed with the same power has always been less with the propeller at the bow than at the stern. The reason is chiefly that the water set in motion by the propeller is driven aft against and along the bow, thereby greatly increasing the resistance to motion. It may be argued that a propeller at the stern acts like a pump and pulls the water away from about the ship, thus also increasing the resistance to motion, and that hence the two propellers are similar in this respect. This is true as far as it goes, but the propeller at the stern has an offsetting advantage not possessed by the one at the bow. It acts in the following current or wake of water set in motion by the ship, and is thus enabled to get from the water a return of a part of the power expended in driving the ship. In short, the loss due to the increase of resistance which comes from the action of the propeller at the stern is practically just about made up by the gain due to the location of the propeller in the following wake. With the propeller at the bow this is not the case, and hence it is at a relative disadvantage, and so far as experience has yet shown, it cannot compete with a propeller at the stern as an economical mode of ship propulsion. The same is true of the combination of two propellers, one at the bow and the other at the stern. Experience has thus far shown the combination to be less economical than a propeller properly designed to absorb the whole power and located at the stern.

If your propeller is as efficient as you believe, it would probably do better to locate one of proper size at the stern rather than to divide it up between two, one at the bow and the other at the stern, as you have done.

Q.—Following is a copy of a sum I got at an examination. Will you kindly work it out for me? What is the H. P. of a compound engine 20 in. and 38 in. by 30 in., steam 113 lbs., revolutions 116, H. P. cylinder cutting off at 3-4 stroke, vacuum supposed to be perfect? Also please say if Grey's method of finding the mean pressure of steam is all right for a H. P. cylinder, as he makes no mention of back pressure. SUBSCRIBER.

A.—In an example like this the power must be figured as though it were all developed in the L. P. cylinder, using the initial steam pressure and the total number of expansions from cut-off in the H. P. to the end of the L. P. In the H. P. cylinder, neglecting the effect of clearance (as we must since no mention of it is made), the cut-off at 3-4 stroke will give 1 1-3 expansion to the end of the stroke. Then this same steam finally fills the L. P. volume, and hence is expanded as many more times as the H. P. volume is contained in the L. P. This ratio will be the same as that between the areas. From a table of areas of circles we find:

Area of 20-inch circle = 314.16.
Area of 38-inch circle = 1134.12.
Ratio = 1134.12 ÷ 314.16 = 3.601.

Hence the steam is expanded 1.333 times in the H. P. cylinder and 3.601 in going from the high to the low. The total expansion ratio is therefore the product of these two, or $1.33 \times 3.6 = 4.8$. We then assume perfect expansion without loss and without back pressure, and find the *mean pressure* by the formula—

$$p_m = p\left(\frac{1 + hyp.\ log\ r}{r}\right)$$

where p is the absolute pressure at the engine and r is the expansion ratio. You state the pressure to be 113 lb., and if this is taken as *gauge* pressure, then the absolute pressure will be greater than this by the pressure of the atmosphere. Taking this at 15 lb., we have $p = 113 + 15 = 128$. From a table of hyperbolic logarithms we find hyp. log. 4.8 = 1.5686.

Hence $p_m = 128\ (2.5686 \div 4.8) = 128 \times .535 = 68.5$. We take next the horse power formula

$$I.\ H.\ P. = 2\ \frac{P L A N}{33{,}000}$$

in which we have:

$$P = 68.5$$
$$L = 2.5$$
$$A = 1134$$
$$N = 116$$

Substituting and reducing we find *I. H. P.* = 1365, the value of the indicated horse power on the basis assumed.

In any actual case there would be, say, 3 lb. back pressure, and the mean forward pressure realized would not be over .75 or .80 of the ideal obtained as by the rule above. This would give, say, 50 lb. as a probable mean pressure in an actual engine working under the conditions and with the steam pressure as stated. Using 50 lb. instead of 68.5 lb. in the horse power formula as above, we find 966 for the horse power, or say 1,000 for a round number.

McFarlane Gray's rule cannot be used for the H. P. cylinder. It gives the mean pressure supposing the vacuum perfect, or no back pressure, the same as the rule used here. In fact, Gray's rule is simply an approximate method of working out the value of $(1 + hyp.\ log.\ r) \div r$.

NEW PUBLICATIONS.

The Naval Annual, 1899. By T. A. Brassey. Thirteenth year. New York, D. Van Nostrand Company, 23 Murray St. Size, 6 1-2 by 10. Pages, 480. With engravings, charts and plans, cloth, $6.00.

This work has come to fill a place entirely its own in the periodical naval literature. Throughout the world it is naturally consulted as a complete and comprehensive digest of the year's naval affairs, with, of course, special reference to the British fleet and its equipment. The present volume seems well up to the standard set by those which have preceded. In the preparation of the matter on foreign navies the editor notes with regret the absence of the assistance of M. Weyl, who in recent years has furnished the matter for this chapter. On the other hand there are several special features, including a special chapter on the U. S. Navy, by Lieut. Com. W. H. Beehler, U. S. N., and a chapter on the naval aspects of the late Spanish-American war, by Col. Sir George Clarke.

Lord Brassey furnishes an introduction on the state of the British Navy, written in Australia at the close of 1898. The subjects of manning the navy and the naval reserves are considered, and especial reference is made to the movement for a colonial naval reserve, and to the conditions under which the colonies and the mother country may unite on a practicable scheme. The recent types of war ships are noted and compared with those of foreign powers, the natural conclusion being reached that both in battleships and cruisers the English types are on the whole superior to those of other nations. The comparative strength of navies, the destruction and protection of commerce, the decay of the Triple Alliance, and the growth of British sentiment and of friendship with the United States, are also touched on in the interesting and instructive style of the writer.

Chapter I on the British Navy, by the editor, gives a well condensed account of the progress during the past year. Due to the exigencies of engineers' strikes and other circumstances, it appears that no battleships were completed during the year, though sixteen were under construction or projected. Of these six are of the *Canopus* class, six of the *Formidable* class, and four of the *Duncan* class not laid down at the time of writing. The work on the various classes of cruisers is also noted and the trial results in several cases are given. The characteristics of the *Cressy* and *Drake* classes and other new designs are noted and compared with those of the *Diadem* class. The points of advance over the latter consist chiefly in an armored belt and in a main battery of two guns of 9.2 inches caliber supported by 6 inch guns, instead of a battery of 6 inch guns alone. The "destroyer" fleet is also discussed, and the recent types are described.

In Chapter II a résumé is given of the year's work in navies other than those of Great Britain and the United States, to the latter of which a special chapter is also devoted. The French, Russian, Italian and German navies naturally receive chief notice, though special note is made of the rapidity with which Japan has within a few years advanced to a naval position demanding serious consideration, and brief descriptions are given of the more notable additions to her fleet.

In Chapter III the question of comparative strength is discussed from a variety of standpoints. The squadrons in commission on the various stations are first compared, but without any attempt to equate ships of different classes. Following this is placed a general comparative résumé of the entire fleets of *Great Britain, France, Russia, Italy, Germany,* the *United States* and *Japan,* the two latter being included in the résumé for the first time. The question of comparative strength is also discussed particularly with reference to the relations of Great Britain to the other European powers, either singly or in combination. This is followed by comparative tables for each type of ship for the different countries, giving in parallel columns for convenience of comparison, the name, date, and displacement. According to these tables and the classification adopted, the U. S. fleet consists of 12 first class battleships, 1 third class battleship, 10 coast-guard and harbor-defense ships, 4 first class cruisers, 11 second class cruisers, and 5 third class cruisers. In the table of gunboats the United States, apparently by oversight, is credited with none instead of the 17 borne on her lists, without counting those recently added from the Spanish navy. In the tables of data following at a later point and giving the more complete showing of vessels for each nation under its own heading, this oversight is corrected, the gunboats appearing as they should.

In Chapter IV is given a comprehensive sketch of the recent development and present condition of the U. S. Navy. The MS. for this chapter seems to have been furnished previous to the passage by the last Congress of the "personnel" bill, so that in reference to this subject the former status is described with a brief reference to this bill, the provisions of which were also briefly referred to in the preceding number of this *Annual.* The various types of ships constituting the U. S. Navy are described in detail, and the leading points in the most recent designs are especially considered. One item of note is the fitting of bilge keels on the destroyers, such step having been taken as a result of experience under cruising conditions in such boats, in which the excessive and lively rolling is found to wear seriously on the crews. The elimination of wood or the substitution of fireproofed wood in all designs is also noted. The recent development of U. S. Naval Ordnance is also discussed, and especial note is made of the new designs for 4, 5, 6 and 8 inch guns of 40 to 50 calibers length.

In Chapter V Col. Sir George Clarke discusses the naval aspects of the Spanish-American war. The causes leading up to the war are summarized and a general comparison is made between the naval and military forces of the two nations. Special note is made of the paralyzing influence on the movement of some of our ships due to fears on the North Atlantic seaboard of a possible descent upon coast cities—fears which by naval officers were probably always considered as absurd to the last degree, and yet commanding sufficient influence to seriously interfere with the freedom of ships for offensive movements on the part of our naval forces. It may be hoped that, at least after

the event, the over timid residents of New England and other cities may be able to recognize how utterly unreasonable and uncalled for were their fears and demands. The battle of Manila Harbor is then briefly considered and the results are discussed. Next taking up the course of events on the Atlantic beginning on the other side with the formation of Cervera's squadron and on this side with the formation of the so-called flying squadron and the bombardment by Admiral Sampson of San Juan and ending with the naval battle of Santiago, the series of movements are given in detail and with much interesting discussion of the questions of tactics involved. Doubt is expressed of the justification for the bombardment of San Juan, a doubt which is perhaps not new to many on this side of the Atlantic. The game of hide and seek between Admiral Cervera's ships, the two U. S. squadrons, the squadron of scouts and the cable is followed through as it can be now when all is known, and the final victory for the cable and the apparent ineffectiveness of the big and fast scouts is noted. The author points out that while the facts could not, perhaps, have been known at that time, present information would seem to show that there should have been no difficulty in sailing east to meet Cervera's squadron and in keeping in touch with them from the time when picked up, and in thus fulfilling the purpose of scouting in the larger sense. In the actual fact the performance as scouts of these large and fast ships was disappointing, but it is perhaps yet too soon to attempt to assign in detail the causes, and perhaps sufficient allowance is not made for the needle in a hay stack hunt which such a mission involves. The operations of cable cutting are also referred to, and in this connection an error is made which should not go uncorrected. On page 166 it is stated that "On May 11 two steam and two sailing launches from the *Marblehead* and *Nashville* were employed in an attempt to cut the cables off Cienfuegos. Two cables were discovered, but could not be cut under the rifle fire from the shore, which caused nine casualties." All accounts of this operation report the attempt as entirely successful, and in Lieut. Winslow's personal narrative published in the *Century* for March, 1899, the affair is described in detail. From this narrative it appears that 150 feet were removed from the Santiago cable and 100 feet from the Batabano cable, while the number of casualties were two killed, six severely and one slightly wounded. One of the important lessons drawn from the war is the influence which the pernicious activity of the modern sensational press and the politician may have on the conduct of a campaign. This the author summarizes in the following words:

In April, 1898, the naval authorities had a plan of operations carefully matured. The press and the politician supervened, with the natural result that the plan disappeared, and the initial naval proceedings took the form of a compromise strategically indefensible. The incompetence of the Spanish Navy was so complete that this sacrifice of principles to popular clamor proved quite unimportant. In less fortunate circumstances it might have been disastrous. War, whether by sea or land, is a game that can be effectively played only by experts acting in accordance with great principles. In free countries, where the views of sailors and of soldiers are always liable to be regarded with suspicion, there is a real danger that the direction of warlike operations may be warped by an uninstructed popular outcry. This, to the United States and to ourselves, is perhaps the greatest lesson of the recent war.

In Chapter VI a more detailed comparison is made between representative ships of the leading naval powers in the battleship and cruiser types. Details of the ships and of their armament, are given, and comparisons are made of the gun fire per ton of displacement. What curious things figures may be made to prove is well illustrated in the treatment of the new U. S. S. *Maine* now building. The armament is given correctly, but in calculating the energy of gun fire the energy per gun is taken from the 12 inch guns now afloat, and for the old type of 6 inch guns, while for the ships of all the other nations the computations are based on the latest designs. This would give for the *Maine* an energy of 30.3 ft. tons per ton of displacement, which by a further numerical error is reduced to 22.32, the others ranging from about 35 to 52. In a foot-note, however, it is stated that should the *Maine* receive guns equal to those of modern English design, the total energy per ton displacement would be 44.8, a figure comparing favorably with those of other navies. It is perfectly safe to say that the *Maine* will have ordnance of the new U. S. naval design, and certainly not notably inferior to that of other nations, so the assumption of a gun fire energy 30 per cent. lower for the same guns than for other navies seems quite unnecessarily unfair. If in addition the full designed muzzle velocity of 3,000 f. s. should be assumed, the total energy would be raised to 656,000 ft. tons, thus heading the list, and giving a value of 52.5 ft. tons per ton of displacement. In a similar comparison between ships of the cruiser class the United States is omitted, and rightly, since we have had no recent designs of this class.

In Chapters VII, VIII and IX are discussed respectively the question of British coast fortifications, the operations of the Nile gunboats in the Soudan campaign, and the French and German naval maneuvers of the year.

In Chapter X the advances in marine engineering are briefly discussed by G. R. Dunell. The voyage of the *Oregon* is mentioned as showing how much may depend on the efficiency of the engineer's force, and a word is spoken in behalf of this tardily recognized part of the ship's complement as a factor of the very highest importance in the value of a war ship from the fighting standpoint. The rapid advances of the water-tube boiler toward general adoption for naval purposes, and especially the declaration in its favor by Admiral Melville, are noted as perhaps the most significant indications of the year. The difficulties attending the attainment of high economy by naval engines, triple versus twin screws, the growing importance of balancing engines, the advances made with nickel steel for shafting and for plates, and the Parsons steam turbine as a motive power for destroyers, are among the other topics discussed in this chapter, which closes Part I.

In Part II are given the usual alphabetical lists of ships of all navies, with their chief particulars. It is these lists which give to the *Annual* one of its chief values, and the present issue follows the lines of its predecessors, and is apparently up to its accustomed high standard of accuracy and completeness. In the

U. S. list are included the principal auxiliary cruisers enrolled during the Spanish-American war. Accompanying these lists are the usual illustrations showing the distribution of the armament, offensive and defensive, of the leading type ships of the various navies. Many of these plates are new and full page, adding much to the pictorial value of the book.

In Part III a special discussion is given of the advances in ordnance and armor during the year, and the usual tables of British and foreign ordnance are given. In the U. S. tables the new designs are entirely lacking, an omission which may perhaps explain the low energy given to the battery of the *Maine* as referred to in the foregoing. In the development of armor the advance of the Krupp process is the feature of principal importance. Accompanying this are found also tendencies toward a reduction in the thickness of the belt, and a large increase in the amount of side covered by the armor, such changes being peculiarly favored by the increase in the resisting power given by the Krupp plates. The latest typical arrangement according to these ideas involves the fitting of a belt not exceeding 9 or 10 inches in thickness, and above this covering practically all of the side, or at least all behind which guns are placed, with plate of about 6 inches thickness. In discussing the problems connected with the modern naval gun, the difficulties attending the use of cordite and other smokeless powders are emphasized, especially the scoring of the tube and the falling off in service of the velocities attained on test trials. The rapidly increasing amount of powder required for increasing velocities is also noted, and the opinion is given on the authority of Captain Honner, R.N., that a service velocity of about 2,500 f.s. is the highest practicable under present conditions. This opinion is of interest in connection with the new U. S. designs which are expected to give 3,000 f.s.

Taken as a whole the present issue of the *Annual* seems to justify the high expectations which its predecessors warrant us in forming, and while in such a mass of statistical matters errors of the character mentioned here are almost impossible to entirely avoid, the only wonder is that they are not more numerous or more serious in character.

Italy and Her Position as a Naval and Military Power. By Cristoforo Manfredi. Enrico Voghera, Rome. Size 5 1-2 by 8 1-2. Pages 73. With numerous vignettes.

This pamphlet is a reproduction or second edition of a series of papers published first in 1892. Its purpose is to arouse the Government and people of Italy to a realizing sense of their situation—as seen with the author's eyes—and to aid in the general agitation of questions of national defence and growth, as viewed from the standpoints of modern political, military and naval science. Especial stress is laid on the "struggle for prosperity" as the one controlling feature of the modern political situation, and France and England are noted as the chief rivals whose operations may be expected to interfere with those of Italy. The author claims for the land frontier, especially between France and Italy, that the latter, aided by the natural defences furnished by the Alps, is in a position to repel any army of invasion likely to be brought against it. The same is, however, far from true relative to the navy as the protector of the coast frontier, and based on this proposition a powerful plea is made for the upbuilding and strengthening of the navy as a means of coast defence. The author points out also that surrounded as Italy is on the land, and fixed as are now the general geographical boundaries of the powers of Europe, the only way open for expansion is by the sea, and to utilize this pathway a navy is needed which shall follow the Italian with the protection of his flag, and which shall be able to protect his interests whenever and however they may be imperiled. In the concluding chapter is given an interesting discussion of the political equilibrium in the Mediterranean, and a final and strong appeal is made for a navy which shall be as efficient a protector for the coasts of Italy as are the Alps and their forts for the land frontier. The author is very much in earnest with his subject, and writes with great vigor. His pages abound in familiar truths, forcefully put, and often in a new light. The pamphlet should do its part in calling the attention of the Italian people to these questions of national growth and defence, though perhaps the ideal of the author is yet a long way off.

Increasing interest in the merchant marine and the navy which has followed upon the war with Spain has given an impetus to publications of the character of the "Blue Book," just issued from the press. This book, which the publishers claim is the only marine and naval directory of the United States, is this year more handsomely illustrated than ever, and is put out in a more convenient form. It is not only a book of reference for the ship-builder, ship-owner and naval architect, and the merchants and manufacturers who have dealings with these interests, but it contains also a hundred or more pages devoted to statistics of water commerce and to general information regarding the merchant marine and navy. Among noteworthy features incorporated in the 1899 edition is a comprehensive history of the year in everything pertaining to the construction and navigation of vessels. The directory part of this publication contains particulars of American steam and sail vessels, with names and addresses of owners, separated as to coasts, Western rivers and Great Lakes; lists of shipowners, ship and engine builders, naval architects, marine engineers, vessel masters, and members of various organizations made up from the navy and merchant marine; particulars of vessels of the United States Navy; heads of government bureaus in the United States and Canada connected with shipping; steamship lines, including those operating to foreign ports, with details of service, principal offices and names and addresses of managers. The Blue Book is published by The Marine Review Publishing Co., Cleveland, Ohio, and will be forwarded to any address upon receipt of $5.

The steam yacht *Fra Diavolo* was sunk in the North River, New York, by one of the Merritt & Chapman Company's tugs July 7 last. There were ten passengers on the yacht, and the crew numbered several men. All were taken off in safety before the vessel sank. The cause of the collision was said to be due to a mistake in signals. The *Fra Diavolo* was a wooden, single screw, schooner rigged yacht, in length 107 ft., and of 64 tons gross tonnage. She was built at Tottenville, S. I., in 1880 for E. S. Stokes, of New York.

MARINE ENGINEERING.

Vol. 4. NEW YORK, SEPTEMBER, 1899. No. 3

PARTICULARS OF THE MARINE MONSTERS OCEANIC AND GREAT EASTERN.

Within a few days the magnificent new liner *Oceanic* of the White Star Line will arrive in New York on her maiden trip. In our issue of February last we published photographs showing the huge vessel before and after launching, and we now are enabled to present to our readers views of the new liner as she appeared shortly before leaving the yard of Harland & Wolff, Belfast, where she was built. When ready for her transatlantic voyage (commencing September 6) she will, of course, sit deeper in the water, but even at the light draught it will be observed that she is an uncommonly handsome vessel of the modern type, and really recalls the definition of Rudyard Kipling, who says: "The liner she's a lady." In the view off the port bow, which is our frontispiece, the shapeliness of the *Oceanic* is specially noticeable. Her stacks for instance, though really huge, being elliptical in section do not dwarf the vessel, an objectionable feature in bow views of the Cunarders, *Campania* and *Lucania*.

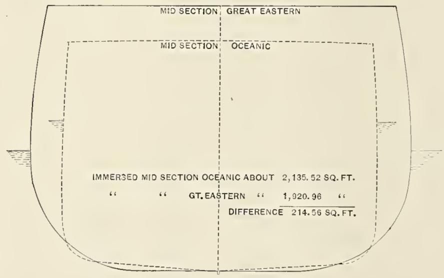
TWIN SCREW WHITE STAR LINER OCEANIC SHORTLY BEFORE LEAVING HER BUILDERS' HANDS.

In connection with the dimensions of the *Oceanic* a comparison naturally is drawn, in the minds of those who follow the sea, with the famous *Great Eastern*. On page 95 we reproduce an original photograph of this deceased leviathan of the deep. At the time it was taken she had finished her career of real usefulness and was in use as a floating advertisement for an English storekeeper. An advantage in this fact for purposes of comparison is that she was light when the photograph was taken, the same condition as the *Oceanic* is here presented in.

In the issue before referred to we gave many particulars of the *Oceanic*, and now add some additional information in the shape of details, and we shall also here give a general description of the *Great Eastern*, so that an intelligent comparison of the vessels will be possible. Both were so huge that special problems in construction and launching presented themselves. Harland and Wolff, builders of the *Oceanic*, and in fact of all the White Star vessels, really anticipated the difficulties that they would encounter. As a first step the ground on which the vessel was to be built was piled and overlaid in part with boiler plate, and a cofferdam was built a considerable distance beyond high water mark—the vessel being laid down for an end on launch. The advantage of this was plainly seen when the cofferdam was removed for the launch, and the water came up fully one-quarter of the vessel's length, rising at the stern to the lower tips of the propeller blades. In this way she was fully waterborne much sooner than she would have been if built on ways in the usual manner. There was a depth of 36 ft. of water at the end of the lying ways, which went as far as the line of the cofferdam. The ways had a mean inclination of 1-2 in. per foot. When entering the water the *Oceanic* dipped to the 32 ft. mark.

At the beginning of building operations an immense traveling crane was erected over the ways, taking in 98 ft. in height and 95 ft. in width in the clear. The crane or gantry was chiefly for the purpose of handling the hydraulic riveting machines with which much of the erection work was accomplished. The aid of electrically driven drills was also employed extensively to ensure accurate work. A repetition here of the general dimensions will serve to recall the vast size of the structure. These are: Length over all, 704 ft.; between perpendiculars, 685 ft.; beam, 68 ft., and depth moulded, 49 ft. 6 in. When she was launched little of the machinery other than pumps and capstans was on board, and the launching weight was between 10,000 and 11,000 tons. The hull contains 17,000 steel plates of an average of 28 ft. in length, 4 ft. 6 in. in width, and from 1 in. to 1 3-8 in. in thickness, each weighing anywhere from two tons to three and a half tons. There were used in her construction about 1,700,000 steel rivets, some of which were 7 in. long and 1 3-8 in. thick. The frames are of channel steel, 9 in. deep with 4 in. and 4 1-2 in. flanges. She has a cellular double bottom the entire length about 5 ft. deep, increased to 7 ft. under the engine seatings. There are five steel decks, and in addition the usual promenade and boat decks. The hull contains thirteen 'thwartship watertight bulkheads, and one longitudinal bulkhead 97 ft. long separating the starboard from the port engine room. An outside bar keel 18 1-2 in. wide and 3 1-2 in. thick laid flatwise is rivetted through to the inside plate keel, which is 4 ft. 6 in. wide and 1 3-8 in. thick, laid in plates 30 ft. long.

A few secondary dimensions help to convey an idea of the magnitude of the vessel. The stern post with the inside brackets for carrying the stern tubes weighs 98 tons, the rudder complete weighs 53 tons, and the hawse pipes, made of steel castings, each weighs 7 tons. Her anchor cables are 3 1-4 in. bar, and the handling gear is, of course, heavy in proportion.

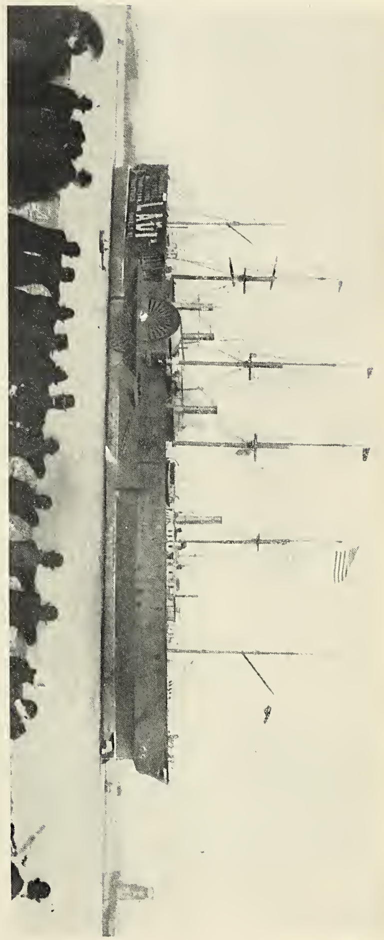


COMPARATIVE CROSS SECTIONS.

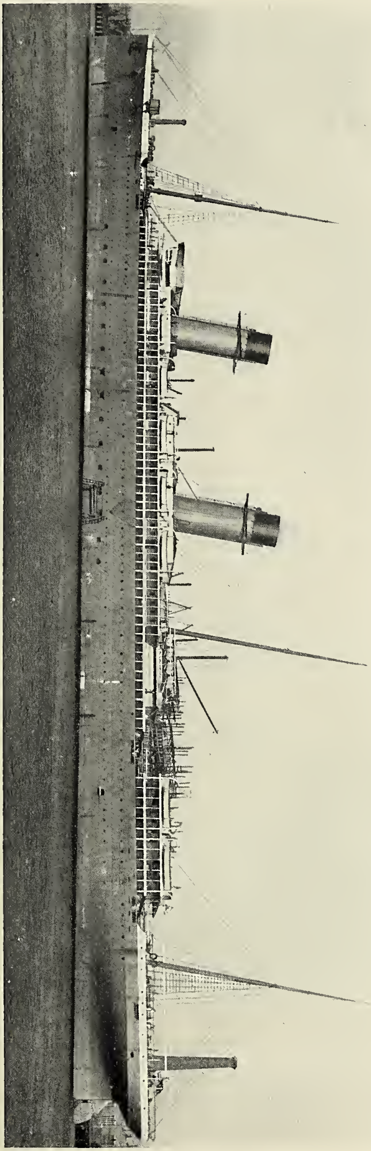
In common with modern practice the *Oceanic* is fitted with bilge keels for a length of 250 ft. on the sides, each keel being 18 in. deep. When fully loaded it is calculated she will draw 32 ft. 6 in. of water, and will displace 28,500 tons. If loaded to this depth she would not be able to come up on her dock at New York at low water, for there is then only 30 ft. in the ship channel. At mean high water this is increased to 34 ft. 6 in. which would give 2 ft. between the keel and the bottom.

The *Oceanic* has bunker capacity for 3,700 tons of coal, and if needed she could steam 23,400 miles, or around the world at 12 knots speed without recoaling. This is a point on which much emphasis was laid across the water when she was under construction. She is built to conform to the British Admiralty regulations for auxiliary cruisers, and in time of war she could be used to great advantage as a transport, steaming long distances without stoppage and carrying a great number of troops.

In her construction and equipment very great care has been taken to provide for all possible emergencies.



ORIGINAL PHOTOGRAPH OF THE LATE SCREW AND PADDLE STEAMSHIP GREAT EASTERN.



WHITE STAR TWIN SCREW TRANSATLANTIC LINER OCEANIC, THE LARGEST VESSEL IN THE WORLD BUILT OR BUILDING.

Not only are the main engines in duplicate, but a system of duplication has been adopted throughout, so that no ordinary breakdown or mishap could disable the ship. As a precautionary measure the rudderpost has been covered with a mass of white metal cast in place to prevent any serious corrosion which might be caused by galvanic action due to the use of bronze for the propeller blades. We have previously given the principal details of her main engines and boilers, but hope to give further particulars in a future issue.

Passenger accommodation on the *Oceanic* is naturally very extensive, and is provided for with all the ingenuity of resource that long experience in transatlantic travel can suggest. The main saloon is 80 ft. by 64 ft. and 9 ft. high in the clear, and there is a central dome 15 ft. dia. The room will accommodate 350 passengers at one sitting. There is accommodation for 410 first-class, 300 second-class and 1,000 third-class passengers. Some of the staterooms measure 13 ft. 6 in. by 9 ft. Beside the transients the vessel will carry 390 in the crew, and when filled, in the season, she will have on board 2,100 souls.

Though an unusually large job for a shipyard that makes a specialty of big work her construction was very expeditiously carried on. Her keel was laid in February, 1897, but the real work of hull construction was long delayed owing to delay in getting the traveling gantry, before referred to, in position. Most of the constructive work was done within about 12 months. She was launched January 14 of the present year. When she starts out from Liverpool she will represent an investment by the owners of about $5,000,000.

DESCRIPTION OF STEAMSHIP GREAT EASTERN.

In the year 1851 a corporation called the Eastern Steam Navigation Co. was formed in London for the purpose of operating an overland route between Great Britain, India, China and Australia. Failing to secure a Government contract for carrying mail, the company turned its energies to an all water route. The plan adopted contemplated the construction of vessels of large size, making the voyages out to central points of distribution, and the redistribution of freight and passengers by subsidiary lines in eastern waters. The company conferred with Isambard Kingdom Brunel, the famous English engineer, as to the possible construction of a great steamship, and he figured out a set of dimensions, etc. to meet the case. He was given authority to make contracts for the construction of the ship which was to be named the *Leviathan*. Mr. Brunel had already held consultations with J. Scott Russell, naval architect, and to the latter is due the credit for the lines and the practical construction of the vessel. The dimensions finally decided upon were: Length, over all, 692 ft.; length between perpendiculars, 680 ft.; width of hull, 83 ft., width across paddle boxes, 118 ft.; depth moulded, 58 ft. She was to be propelled by side wheels and a single screw, and to have in addition sail power with a spread of 6,500 sq. yds. of canvas.

The contract for the hull and the paddle engines was given to Scott Russell & Co., of London, and for the screw engines to James Watt & Co., of Birmingham. Preparations were at once begun at Milwall on the Thames, where the ship was to be laid down. The soil consisted of a thick layer of mud on gravel, and, as in the case of the *Oceanic*, piles had to be driven to make a foundation. The ways were laid so that the ship was broadside to the water, chiefly for reasons connected with the practical construction of the vessel. One objection to an end on launch was the height to which it would be necessary to elevate the fore part of the vessel when building.

Iron was, of course, the material used for the hull of the new vessel. The plates used were about 10 ft. long by 2 ft. 9 in. wide and, for the outside, 3-4 in. thick, each weighing about 840 lbs. The framing was entirely longitudinal, the longitudinals being 2 ft. 10 in. deep and 1-2 in. thick, placed about 2 ft. 6 in. apart on the flat of the bottom, and from the bottom to a height of 26 ft. they were placed 5 ft. apart. The double bottom of the vessel (later christened *Great Eastern*) was carried up above the water line, and her upper deck was of cellular construction, consisting of longitudinal girders covered top and bottom by 1-2 in. plates. She was single rivetted throughout, except at the butts which were double rivetted. The largest size rivet used was 7-8 in., and all holes were punched. She had no outside bar keel, this being made of 1 in. plate. About 30,000 plates of an average weight of 600 lbs. were used in the construction of the vessel. Her launching weight was between 8,000 and 9,000 tons; the records varying on this as on many other points of her construction.

In the design great care had been taken in the light of existing knowledge for the safety and comfort of passengers. There were twelve watertight compartments below the lower deck, and nine above this deck. In addition there were two longitudinal bulkheads extending from the bottom to the upper deck and for a distance of about 350 ft. fore and aft. There was a space of 2 ft. 10 in. between the inner and outer skins, and this was subdivided into watertight spaces about 6 ft. square. The vessel was flush decked, there being only a few houses on the upper deck to obstruct the regular esplanade which this deck formed. There were four decks in all. A tremendously large space was available for passenger accommodation, the number which could be carried being: Saloon, 800; intermediate, 2,000, and steerage, 1,200. The main saloon was a fine apartment, 100 ft. by 36 ft. and 13 ft. high, and was lighted by skylights.

The propelling machinery was huge for its time, though it would not be considered specially so now except in comparing bulk with power. The paddle engines were simple, with four cylinders, each 74 in. dia. and 168 in. stroke, and when turning about 14 revolutions were expected to develop 3,500 I. H. P. Each cylinder, with piston and rod, weighed nearly 40 tons, and the crank shaft weighed about 30 tons. The screw engines were simple, horizontal, direct acting, with four cylinders, 84 in. dia. and 48 in. stroke, and turning at 55 revolutions were expected to develop 4,500 I. H. P. The cylinders were placed two on each side of the crank shaft with a platform between, and one of the most impressive sights on a ship fitted with many such view points was to stand on this platform and look up at the skylight above. It had something of the effect of looking up the elevator shaft of the modern skyscraper.

There were ten main boilers in all in the ship, those for the screw engines differing but little from those for

the paddle engines. They were of the double ended multitubular box type, built for a working pressure of 20 lbs. and were on the average in size: Length, 18 ft.; width, 17 ft. 6 in.; height, 14 ft., and weight 54 tons. There were 112 furnaces altogether, and the daily coal consumption at full speed was 400 tons. The coal bunkers were carried along the sides, and there was a total capacity of 12,000 tons, so that if need be the vessel could steam out to the East and home again without recoaling.

Important Vessels of the Leading Lines Now Engaged in Transatlantic Trade.

Line.	Name of Vessel.	Date.	Length Between Perps.		Breadth.		Depth.		Load Displacement.	I. H. P.	Sea Speed.
			Ft.	In.	Ft.	In.	Ft.	In.	Tons.		Knots.
	Great Eastern*	1858	680	0	83	0	58	9	27,000 (?)	8 000	13½ to 15
White Star	Oceanic	1899	685	0	68	0	49	6	28,500	28,000 (?)	20 (?)
Ham. Amer	Deutschland (bld'g)	1899	662	6	67	6	44	0	23,000	35,000 (?)	23 (?)
Nor. Ger. Lloyd	Kaiser Wilhelm der Grosse	1898	625	0	66	0	43	0	19,684	27,000	22.25
Cunard	Lucania	1893	600	0	65	0	41	6	19,000	30,000	21.75
American	St. Paul	1896	535	0	63	0	42	0	16,000	20,500	21
French	La Touraine	1891	520	0	56	0	34	6	11,685	12,000	19.5
Anchor	City of Rome**	1881	560	0	52	0	37	0	12,000	11,000	17
Can. Pac.	Empress of Japan†	1891	485	0	51	0	36	0	8,500	10,000	18.5
Dominion	New England	1898	550	0	59	3	40	0	20,000	8,700	16
Holland-America	Statendam	1898	525	0	59	8	43	6	17,000	6,200	15

*Screw and Paddle. **Single Screw. †Trading Between Vancouver and Yokohama.

The side wheels of the vessel were 56 ft. extreme dia., each weighing in excess of 90 tons. There were 30 floats in each wheel, in size 13 ft. long and 3 ft. wide. The screw was 24 ft. dia. and 44 ft. pitch.

Work on the vessel commenced in the yard on May 1, 1854, and she was ready for launching November 3, 1857. Two cradles had been provided to carry the vessel down the launching ways, the latter being about 300 ft. long and 120 ft. wide, and placed 120 ft. apart. The launch was a failure as the hull moved but 6 ft. and then stuck. Subsequently many attempts were made to get her into the water without success until January 31, 1858, when she was floated. The cost of these launching operations added enormously to the cost of the vessel which had already far exceeded the preliminary estimates—in fact the vessel in her uncompleted condition cost about $3,650,000. The resources of the company were exhausted and a new corporation was formed to complete the vessel at an additional cost of about $600,000. The original scheme to engage in the far eastern trade was then abandoned.

During the years '60 to '63 the vessel was engaged in the Atlantic trade. On her first trip West she started from Southampton, in the month of June, and after a passage of 11 days 2 hours she arrived at New York, having run 3,188 miles. This trip was made under rather unfavorable conditions. The firemen were green and did not keep up a good head of steam, and the above deck crew was new to the vessel. Then a good deal of time was lost through fog. The maximum speed on the trip was 14 1-2 knots, and the average, counting

DISTANT VIEW OF THE NEW TWIN SCREW WHITE STAR MAIL, PASSENGER AND CARGO STEAMSHIP OCEANIC.

steam time, was about 13 knots. When she started from England her draught was: forward 22 ft. and aft 26 ft. During subsequent passages the *Great Eastern* met with several minor mishaps, tearing out part of her double bottom on one occasion on the Long Island coast, but at no time was she in serious danger. The Atlantic service did not prove profitable, however, and the big ship was taken off. Her subsequent services in laying the Atlantic cable are well known, and need

not be recounted here. After the completion of cable work the *Great Eastern* was laid up idle in Milford Haven. Many years afterward she was sold to an enterprising English retail merchant who used her for advertising purposes, and she visited various home ports. In the late eighties or early nineties she shared the fate of all vessels not lost at sea and was sold to a ship breaker to be reduced to scrap on the banks of the Mersey.

Institution of Naval Architects.

At Newcastle-on-Tyne, England, the summer session of the Institution of Naval Architecture was opened on July 18 last by the President, the Earl of Hopetoun. The opening was ceremoniously carried out, the Mayor of Newcastle and members of the Council forming a reception committee to give welcome to the assembled members. Those present included many of the leading British shipbuilders and engineers and several foreign guests. After the Mayor had welcomed the visitors the president delivered the opening address, touching upon the fact that the port was one of the oldest in the country, it having supplied a number of vessels to King Edward III's navy several centuries ago. At the session a number of important papers were read, which included: "The Rise and Progress of Rifled Naval Artillery," by Sir Andrew Noble; "The Distribution of Pressure Over the Bottom of a Ship in Dry Dock and Over the Dock Blocks," with special reference to the *Fulda* mishap, by Dr. Francis Elgar; "A New Method of Forced Draft," by Nelson Foley; "Elswick Cruisers," a descriptive paper, by Philip Watts, chief of the Armstrong shipbuilding plant; "Boiler Arrangements of Certain Recent Cruisers," by F. T. Marshall; "European Ice Breakers," a descriptive paper, which will be found reproduced in another portion of this issue, by H. F. Swan; "Nickel and Mild Steel Tubes for Water-Tube Boilers," by A. F. Yarrow; "Large Atlantic Cargo Steamers," by G. B. Hunter; and "Experiments on Thrust Block Friction," by F. Von Kodolitsch.

As the Tyne is a large shipbuilding center, an extensive programme of visits and social functions had been prepared. One of the most interesting visits was that paid to the immense works of Sir W. G. Armstrong, Whitworth & Co., Ltd., at Elswick, where luncheon was served. Among the vessels in course of construction, viewed by the visitors, were a Japanese battleship, two armored cruisers, two Norwegian armored vessels, and other war ships, including the U. S. cruiser *Albany*, which, it will be remembered, is a sister ship to the U. S. cruiser *New Orleans*, now in our service. The steel works also attracted a good deal of attention, and in the ordnance shops the manufacture of heavy cannon, from 12 in. downward, was examined in detail. Considerable amount of time was also spent in the engine works, where machinery for various vessels was under construction. The works of C. S. Swan & Hunter, at Wallsend-on-Tyne, were also visited, and among the vessels here viewed was a new cargo steamer for the Cunard line, 600 ft. long. The great shipbuilding sheds, 500 ft. in length, with glass roofs, were also viewed with interest by the visiting shipbuilders. Visits were also paid to Palmer Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne. These works cover nearly 100 acres, and have a water front of nearly 4,000 feet.

OUTLINE OF THE BRITISH NAVAL MANŒUVRES RECENTLY CONCLUDED.

British naval manœuvres for 1899 came to a practical conclusion on August 4 with the safe arrival of the fleet representing the "British" at its destination, Milford Haven, on the west coast of England, with the ships it had gone out to convoy. No vessels of the fleet representing the "hostiles" had been met with, and while the victory of the "British" fleet was complete it was technically bloodless. Mobilization for the manœuvres took place July 11, and hostilities commenced the last week in July.

The chief purpose of the manœuvres was to ascertain how best to employ a large number of cruisers in conjunction with a fleet having many vessels of the battleship class. It was also the purpose to gain information as to the relative advantages and disadvantages of speed vs. fighting capacity, and to get a line upon the effective handling of torpedo boats and destroyers. The opposing fleets were known as the "A" and "B" fleets, respectively. The official programme was as follows:

A British convoy "C" of slow ships escorted by a fast cruiser on passage from Halifax to Milford Haven is ordered to wait at a certain rendezvous the arrival of a protecting squadron.

N. B.—The slow ships cannot be taken in tow, must remain in company and have no fighting value.

A hostile squadron "A" of fast ships, lying at Belfast, is sent to sea to intercept and capture the convoy and bring it to Belfast. After an interval a superior British squadron "B" of slower ships is sent to protect the convoy "C" which has been ordered to a prearranged rendezvous, cover it from the hostile squadron, and bring it into Milford.

The whole of Ireland is "hostile" territory, and belongs to "A."

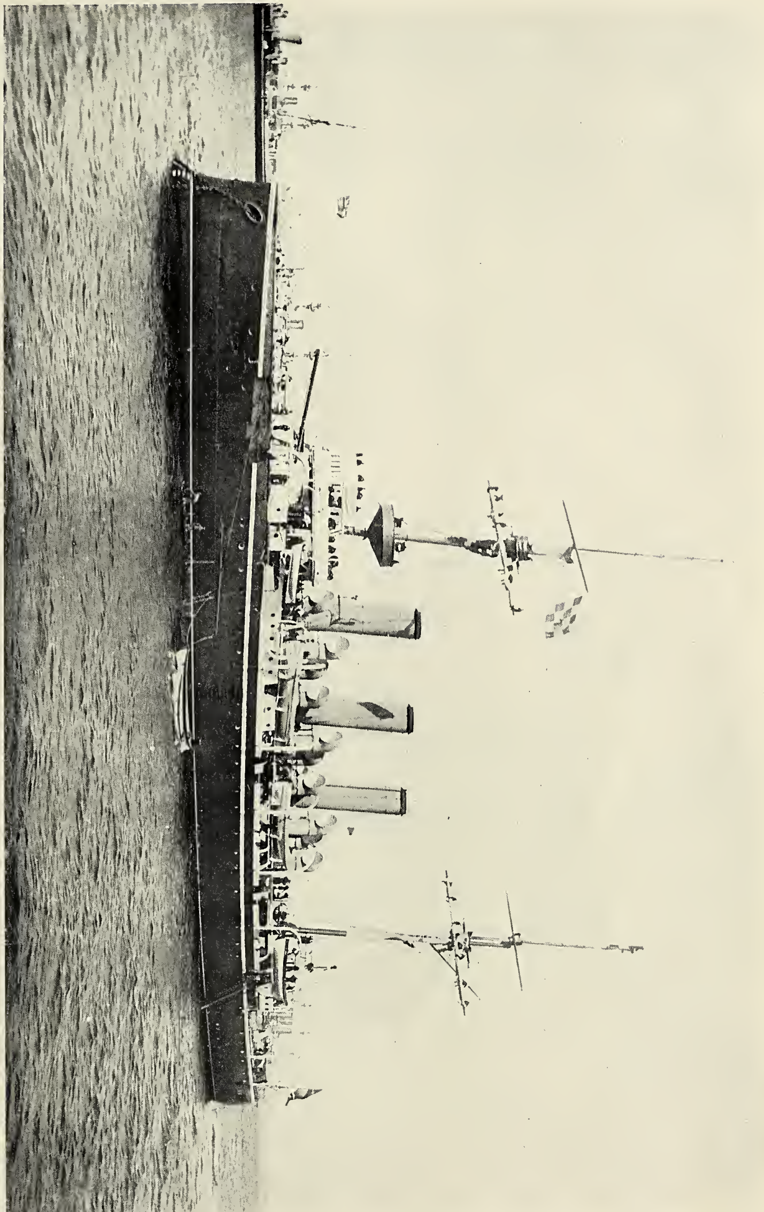
The coast of England and Wales from the island of Islay to the Lizard, including the Scillies and the Isle of Man, is "British" territory.

The hostile fleet "A" has torpedo boats at Waterford, Kingstown and Belfast.

The British fleet "B" has destroyers at Milford Haven, Holyhead and Lamlash.

The "A" fleet, under command of Vice-Admiral Sir Harry Rawson, with Rear-Admiral Arthur D. Fanshawe second in command, consisted of eight modern battleships, three first-class, fourteen second-class, and two third-class cruisers and twenty-four torpedo boats. The "B" fleet, commanded by Admiral Sir Compton Domville and Rear-Admiral Pelham Aldrich, second in command, was composed of ten battleships (some old), four first-class, sixteen second-class cruisers, and twenty-eight destroyers.

Admiral Domville, in command of "B" fleet, knew the exact spot where he would find the convoy (a point about 350 miles due west of Bantry Bay on the Irish coast), whereas Admiral Rawson had no exact information as to the point of juncture or the course to be subsequently taken. He had, of course, a knowledge of the general direction of the course taken by the convoy on its supposed westward voyage. The "A" fleet, though inferior to the "B" fleet in strength, was superior in the matter of speed, and was given a start of 19 hours, from Belfast, Ireland, ahead of "B" fleet, which went out from Milford Haven. The convoy, known as "C," consisted of the slow cruisers



BRITISH SECOND-CLASS CRUISER FURIOUS, 5,700 TONS, WHICH TOOK PART IN THE RECENT NAVAL MANŒUVRES.

Calliope and *Curacoa*. The "A," or hostile fleet, had the misfortune to run into a thick fog which lasted the greater part of two days, and to this is due, no doubt, some share of the success of the "B" fleet—whether such a fog would conveniently blanket a hostile fleet in time of genuine war is something that even the Admiralty experts cannot guess.

The "B" fleet on leaving Milford Haven took a course which would be least likely to bring it into contact with the enemy's ships, as the convoy was the objective point at this period of the operations of "B" fleet. The *Europa*, a powerful 20-knot cruiser, was sent ahead to connect with the convoy, and she was followed by the cruiser *Juno* at a considerable distance ahead of the fleet. Both these ships were fitted with the Marconi instruments for wireless telegraphy and the flagship of the "B" fleet was similarly provided with means of distant communication. Very great success attended this practical test of the apparatus. When the *Europa* reached the convoy the *Juno* was 55 miles distant, and yet the message announcing the connection made by the *Europa* was plainly received on the *Juno*, which vessel in turn passed the message along to the flagship, then 30 miles astern of the *Juno*. The distance of the fleet from the convoy when the message was received will be more clearly appreciated when one learns that the message was received on board the flagship at 7.30 o'clock in the evening, and though the vessels of the fleet and convoy were then approaching each other at the rate of 21 knots, it was not until 11 o'clock the same night that they met. During the run out of the "B" fleet the *Juno* went ahead at a distance of about 10 miles and performed valuable service in signaling the presence of fog banks, fishing vessels, etc., so that long before the fleet met these each captain had been warned from the flagship what to look out for.

After a juncture with the convoy was effected by the "B" fleet, the course was shaped for Milford Haven, which was reached without contest. The speed was necessarily slow, as the best that one of the "B" fleet battleships—H. M. S. *Thunderer*—could do was between 11 and 12 knots.

There were several minor engagements between the torpedo boats of the "A" fleet and the destroyers of the "B" fleet, stationed at the Irish and English harbors, and in each case the destroyers claimed the victory.

A number of rules and regulations were, of course, laid down so that the commanders of the ships would have equal knowledge of the arbitrary offensive powers allotted to each class of vessel. All battleships engaged were to be considered of equal power, and the superiority of one battle squadron over another was to depend alone upon that which had the greater number of battleships. Other regulations provided that no cruiser of a lower class could count against a cruiser of a higher class, and that a torpedo fired at a ship had to be within a distance of 500 yards; and so on, covering all the chief points that would be likely to occasion serious dispute. One object of the Admiralty in this seemed to be the prevention of independent and desultory fighting and the concentration of effort on efficient scouting and fleet evolutions.

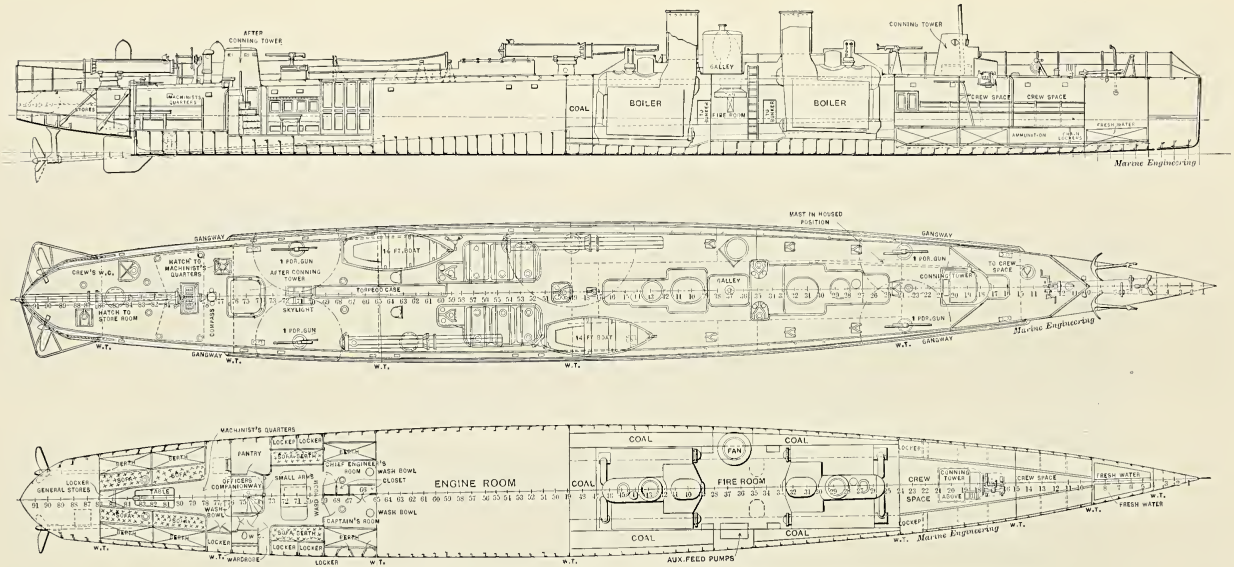
Among the modern vessels which comprised fleet "A" was H. M. S. *Furious*, a photograph of which, as she lay in the harbor of Belfast, the fleet's rendezvous, is reproduced on page 99. This new vessel is a typical modern British cruiser of the second class, and is the more interesting as she is almost directly comparable with the U. S. S. *Olympia*, now on the way home from Manila with Admiral Dewey. They are both twin screw protected cruisers. The *Olympia* is the older vessel, having first gone into commission February 5, 1895, while the *Furious* was put into commission on July 1, 1898. For the purposes of ready comparison we give the accompanying table, showing the chief characteristics of each.

Comparison of the British Cruiser "Furious" with the American Cruiser "Olympia."

Vessel.	Length.	Beam.	Draught.	Displacement. Tons.	I. H. P.	Speed, Knots.	Normal Coal Supply.	Bunker Capacity.	Main Battery	Secondary Battery.	Torpedo Tubes.	Armor.	Complement.
H. M. S. *Furious*..	320 ft.	57 ft.	22 ft.	5,750	10,000	19.5	500	1,175	4 6-in. R. F. 6 4.7-in. R. F.	9 12-pounders. 3 3 pounders. 5 ½-in. Maxim	2	2 to 4.5 in.	450
U. S. S. *Olympia*..	340 ft.	53 ft.	21 ft. 6 in	5,870	17,300	21.6	400	1,169	4 8-in. B.F.R 10 5-in. R.F.	14 6-pounders 7 1-pounders. 2 Colts.	6	2 to 4.75 in.	450

As will be noticed in the photograph, H. M. S. *Furious* is fitted with three funnels, placed fore and aft, and with two masts with fighting tops. Her engines are vertical triple expansion, and she is fitted with Belleville water-tube boilers. With a total coal capacity of 1,175 tons she can steam 9,000 miles at 10 knots. The hull, which is sheathed, was constructed at the Royal Dockyard at Devenport, and the engines by an east coast private firm. Her conning tower is protected by 8 3-4 in. steel armor.

U. S. S. *Olympia* has triple expansion engines and Scotch boilers, and has, with her maximum amount of coal on board, a steaming endurance of 13,000 miles at 10 knots. She has two conning towers protected by 5 in. armor. In addition to her armor her bunkers are arranged for coal protection, and she has a belt of cocoa fiber at the water line. The big guns (four 8 in.) of the *Olympia* are placed in barbette turrets and protected by armor of a maximum thickness of 4 1-2 in. The cost of H. M. S. *Furious* is given as $1,403,860 and of U. S. S. *Olympia*, as $1,796,000. The *Olympia* was built and engined by the Union Iron Works, San Francisco, Cal. There are four cruisers in the British Navy of the same type as the cruiser *Furious*.



PLANS OF THE UNITED STATES TORPEDO BOATS DAHLGREN AND T. A. M. CRAVEN, BUILT UNDER A GUARANTEE OF 30 1-2 KNOTS SPEED.

NEW U. S. 30-KNOT TORPEDO BOATS DAHLGREN AND T. A. M. CRAVEN.

The construction of the United States torpedo-boats Nos. 9 and 10, since named *Dahlgren* and *T. A. M. Craven*, was authorized by Act of Congress passed June 10, 1896, and the contract for these vessels was awarded to the Bath Iron Works, of Bath, Me., on October 6, of the same year. The contract price for the hull and machinery (exclusive of ordnance equipment and outfit) was $194,000 each.

The principal dimensions of these interesting vessels are as follows:

Length over all	151 ft. 7 in.
" on L. W. L.	151 " 3 "
Beam Moulded	16 " 4 "
" over guards	16 " 11 "
Depth amidship side	9 " 4 "
" " center	10 " 0 "
Mean Draught	4 " 8 "
Draught aft under Propellers	8 " 9 "
" " " Rudder	6 " 11 "

The *Dahlgren* and *Craven*, although designed and built throughout by the Bath Iron Works, are of the "Normand" type. General T. W. Hyde, the president of the Bath Company, whilst in Europe three years ago, purchased from Mons. A. Normand, of Havre, France, a complete set of plans of the *Cyclone*, a 145-ton, 29-knot torpedo-boat, then building for the French Government, and these plans have guided the Bath yard and have proved of great value in working out problems both in original design and detail work. The guaranteed rate of speed of the *Dahlgren* and *Craven* is 30 1-2 knots, this speed to be maintained at sea for one hour.

No other shipbuilding firm in the world has as yet guaranteed this enormous speed on such a small displacement as 150 tons, but the builders are confident that these vessels will not only attain the high speed specified in the contract, but will make this speed and carry the required load of 20.29 tons, on a smaller displacement than that specified.

The steel hull of the *Dahlgren* (now completed) is acknowledged to be the lightest for its size ever constructed, and the machinery is likely to prove to be the lightest per I. H. P. as yet built in this country. The *Dahlgren* has a most pronounced hog sneer, with a much higher bow than the Normand boats possess. She has a square forefoot with strong U sections forward. There is a slight drag aft, and the deadwood stops at a point about 15 ft. forward of the aft perpendicular, forming the sternpost. Here a large balanced rudder is hung, 6 ft. long and about 4 ft. 6 in. deep. The midship frames are well rounded; the greatest beam is about 3 ft. above the load water line, and above this point there is a rapid tumble home. The shapes of the midship frames approach very nearly circular sections, thus giving great natural strength, and it is also well to note that the moment of inertia increases as the vessel is heeled; thus giving a higher metacenter when inclined than in the upright position. The water lines aft are very full, and the vessels have the usual Normand knuckle stern which has proved so efficient.

The frames are spaced 20 in. apart, except in the machinery spaces, where they are somewhat closer and located to suit the engines. There are eight water-tight bulkheads extending up to the main deck, besides a few non-watertight and the usual wing coal bunker bulkheads. The compartments in the forehold (in the hold forward of the boiler-room bulkhead below the lower deck) are used as chain lockers, and for the stowage of ammunition, torpedo war-heads; water tanks for the reserve feed water and fresh water for domestic purposes are also located here. All the available space in the aft hold is used for the stowage of ammunition. The stern of these vessels is of wrought steel, and the stern-post, rudder frame and shaft brackets, or struts, are of cast steel.

All the steel used in the construction of these vessels is high-grade steel galvanized. The steel before being galvanized had an ultimate tensile strength of 78,000 to 84,000 lb., with an elongation of 15 to 22 per cent. in 8 in., and an elastic limit of about 44,000 to 52,000 lb.

The crew is berthed on the lower deck forward. There are berths for twenty-four men, and the quarters are unusually roomy and comfortable for a racing machine. Just abaft the engine-room bulkheads are two large state-rooms, which together occupy the full width of the ship. The starboard room is for the commanding officer and the port room for the chief engineer. These rooms are complete in all their appointments. Just aft of them is the ward room, 7 ft. 6 in. by 16 ft. This room contains the usual mess table, lockers, etc., and two sofa berths. Aft of the ward room is the pantry, the officers' w. c. and the companionway which leads into the aft conning tower. Abaft the officers' quarters and separated from them by a steel watertight bulkhead are the machinists' quarters, 16 ft. 6 in. long and the full width of the boat. Here four berths and four sofa berths are located, also the usual folding table, lockers, lavatories, etc. The space aft of the machinists' quarters makes a most desirable general store room.

An aluminum alloy is used extensively on these boats. The galley, aft conning tower, cases for spare torpedoes, engine hatch covers, cowls, and all deck opening covers are made of this material, 7-64 in. thick. The main deck is covered with linoleum 5-32 in. thick, but a light wood grating in wood patterns will probably be fitted over the boilers on this deck.

Torpedo-boats of the *Dahlgren* class have two short, stumpy-looking smoke pipes. They are only 8 ft. 6 in. high above the deck—a few inches above the awnings—and are of elliptical section measuring about 4 ft. fore and aft and 3 ft. athwartships. The galley, made of aluminum, is located between the stacks. It is only 5 ft. long and 4 ft. wide, but a galley range, coal box, sink and dresser are contained in it. Abreast the galley is a large ventilator cowl about 3 ft. dia., which delivers air to the horizontal ventilating fan used for forced draft, and which is located in the fire room below.

There are two conning towers. The forward one is made of steel, bullet proof. It is of a peculiar shape, for the forward part contains the steering engine and wheel, the helmsman being below the level of the deck so that the lookout can see over his head. The Hyde steam windlass is located just forward of the conning tower. The steering engine is arranged to work the windlass in an ingenious manner. There is no turtle-back fitted on these boats, but a high breakwater runs diagonally aft from the forward side of the conning tower. The aft conning tower, or observation house, is made of aluminum, and, as before stated, forms the companionway to the officers' quarters. The hand steering wheel is placed in this tower.

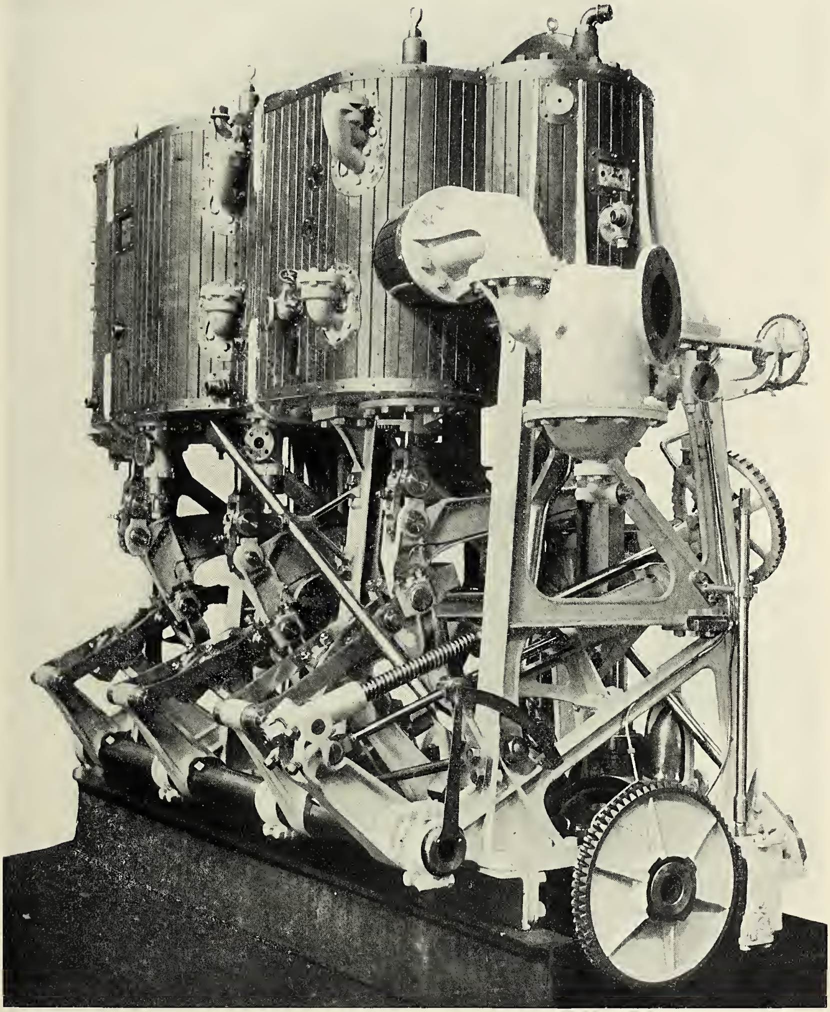
The boilers in these boats are the largest Normand boilers, and they project through the deck considerably, thus necessitating large boiler casings. The engine casings have also had to be made quite large, as the Normand engine is a short, wide engine, and the top of the cylinders on these boats come just about on a level with the deck.

The *Dahlgren* and her sister each carry two 14-ft. cedar boats and the usual U. S. Navy equipment for this class of vessels. They are fitted with two deck discharging tubes for 18-in. Whitehead automobile torpedoes, both of which are located in the center line of the vessel abaft the engine room casing, one being at the extreme aft end of the deck. They also carry a battery of four 1-pdr. rapid-fire guns, two forward and two aft. Coal bunkers are arranged on each side of the boilers, and between the engine and boilers is an athwartship coal bunker. The total bunker capacity is 32 tons, and at full power the consumption will be about 3 tons of coal per hour. About 7 tons of water will be carried in the tanks forward.

There are three large watertight hatches in the main deck with spring covers, which can be opened from either side, communicating with the engine room. Two more lead to the fire room, one leads to the machinists' quarters, one to the general store room aft, one to the crew's quarters, and two smaller hatches give easy access to the back of the boilers. The crew's space is also entered from the forward conning tower. The crew's w. c. is located on the main deck aft. The vessels are rigged with a hinging 30 ft. spar alongside the forward con-

ning tower, which will be used for signaling purposes. A wood fender is worked on the sides of these boats for about three-fourths of their length amidships.

As the propellers project beyond the sides of the boats large pipe propeller guards have been fitted aft, the width over these guards being about 15 ft. The *Dahlgren's* machinery consists of two vertical triple expansion engines driving twin screws. They have each three cylinders, the dia. being 17 1-4 in., 24 7-8 in. and 37 3-8 in., with a stroke of 21 in. The engines are arranged in a common watertight compartment, with the high pressure cylinders forward and the low pressure cylinders aft. The high and intermediate pressure cylinders are fitted with piston valves, and the low pressure cylinders



THREE CYLINDER TRIPLE-EXPANSION ENGINES OF THE U. S. TORPEDO BOAT DAHLGREN.

have a slide valve. These valves are operated by the Stephenson link motion. The engines are very compact, the fore and aft dimensions being reduced to a minimum, the valves being all placed on the side. The distance between centers of the high and low pressure cylinders is only 5 ft. 8 in., and the total height of the engine above the center of the shaft is only 8 ft. 6 in. The over-all length of the engine, including thrust bearing, is 11 ft. 6 in., the over-all width being 6 ft. Each engine is designed to indicate 2,100 I. H. P. at about 320 revolutions per minute, which is equivalent to a piston speed of 1,120 ft. per minute. Each engine is fitted with its own independent condenser, made entirely of sheet brass, of the usual torpedo-boat type; but in the vessels of the *Dahlgren* class great care has been taken with the arrangement of the scoops or inlet and outlet to the condensers. No circulating pump is necessary for ordinary running, as the speed of the boat forces the sea water through the condenser tubes. A small circulating pump is fitted, however, for use in dock trials, etc. The cooling surfaces of each condenser is 1,200 sq. ft., the shell of the condenser being 7 ft. long, of curved form, and 3 ft. 6 in. dia. The tubes are of Muntz metal, tinned, 5-8 in. dia. outside, and they are expanded at the ends into bronzed tube sheets 1 in. thick. The tubes are slightly curved to allow for expansion. Each engine has a single acting air pump, 13 1-4 in. dia. cylinder by 4 1-2 in. stroke, driven from the low pressure crosshead. Also two main feed pumps worked from the intermediate pressure crosshead. The shafts, piston rods, connecting rods, valve rods and working parts generally are of forged nickel steel. The high pressure pistons are made of cast iron, the intermediate pistons of cast steel and the low pressure pistons are of forged steel, the pistons being of equal weight. The bed plates are made of cast steel, and the framing is of Hyde manganese bronze. Each cylinder is steam jacketed. The cylinders are of close-grained cast iron, the barrels being about 3-4 in. thick. The crank, line, thrust and propeller shafts are of forged nickel steel, with a hole drilled axially through them. The crank shaft for each engine is in one section, 6 7-8 in. outside dia. The crank pins are 6 3-8 in. dia. and 11 3-8 in. long. There is a 3 3-8 in. hole bored axially through each crank shaft and a 3 in. hole through each crank pin. The thrust shaft is 6 1-4 in. dia., forged solid with the crank shaft; each shaft has eleven thrust collars. The propeller and line shafts are each in one section, 6 7-8 in. dia., with a 4 5-8 in. hole bored through.

The propellers are made of Hyde manganese bronze, the starboard wheel being right and the port wheel being left-handed. They are each 3-bladed, with a dia. of 6 ft. 6 in. and a pitch of about 12 ft. The blades have an inclined element of 6 in.

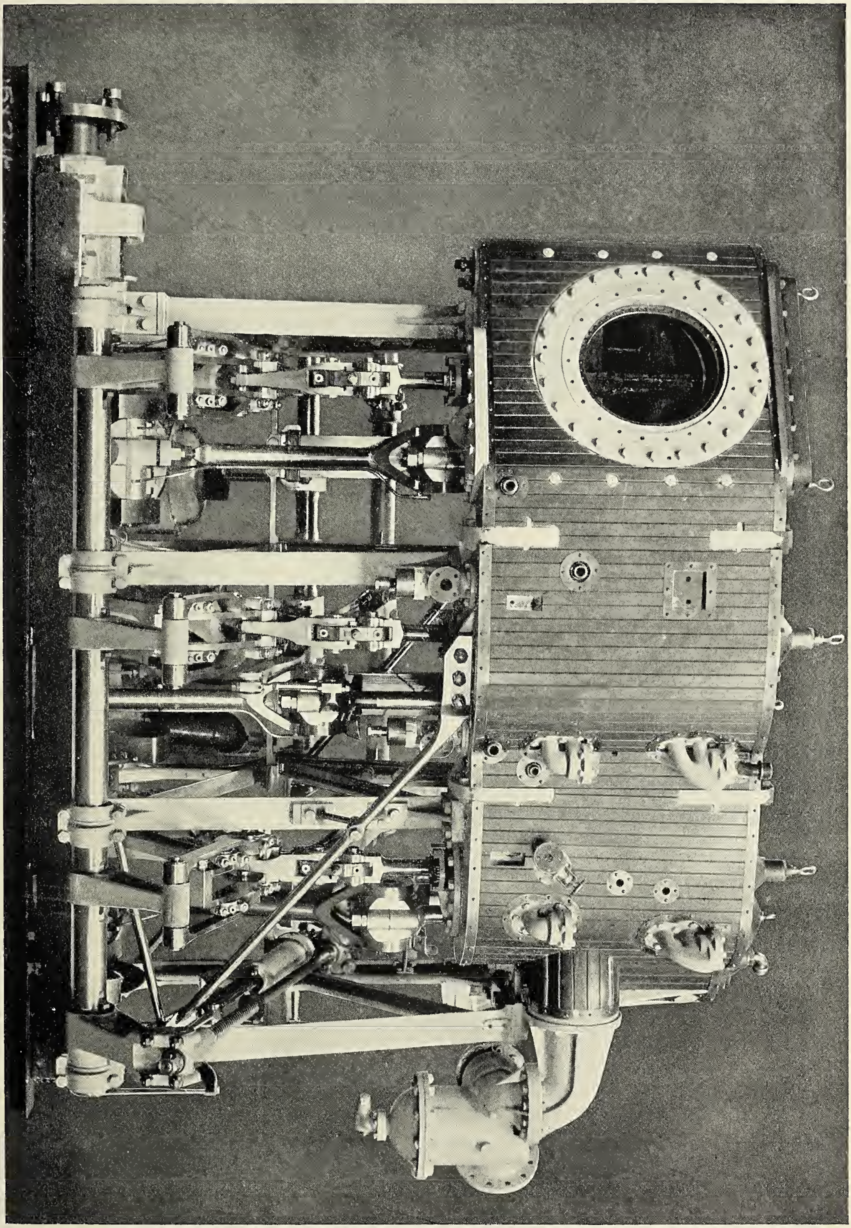
Each vessel is fitted with two brass feed water heaters 14 in. dia. and 5 ft. 3 in. long, the heating surface being about 160 sq. ft. The air compressor, feed water evaporator, distiller for drinking water, and dynamo are located in the engine room.

The machinery of the *Dahlgren* class consists of two distinct independent units. Each engine has its own boiler and condenser. There are, therefore, two Normand water tube boilers of the "Express" type. The grate surface of each boiler is 59 sq. ft., and the heating surface is 2,776 sq. ft. This gives a total grate surface of 118 sq. ft. and a total heating surface of 5,552 sq. ft., the ratio of H. S. to G. S. being, therefore, 46 3-4 to 1. As the designed I. H. P. is 4,200, the I. H. P. per sq. ft. of grate surface designed is 35.6, an unusually high figure, and the heating surface in sq. ft. per I. H. P. is 1.32, an equally low figure. There are 1,550 tubes in each boiler, and these average about 6 ft. long, the outside dia. being 13-16 in. The working steam pressure is 230 lbs. These boilers have an unusually long grate—9 ft. 6 in. The boilers were made as large as possible—indeed, up to the limit in size—so as to obtain the necessary power with but two units, and thus save space and weight with a corresponding increase in efficiency. A large blower, driven direct by a single cylinder engine, is located in the fire room. This fan takes air from the large deck cowl overhead and also from the engine room. Forced draft is fitted in the closed stokehold system, and at full power an air pressure of about 4 in. is expected, the fan making about 750 revolutions per minute. Two auxiliary feed pumps are also located in the fire room.

The electric plant is very complete for vessels of this type, but no searchlights are fitted. The dynamo is a 1 1-2-kilowatt Riker machine, direct coupled to a Sturtevant engine. The drainage system in these vessels include seven steam ejectors, with a capacity of 100 tons each per hour, situated in the different compartments amidships, and two ejectors with a capacity of 20 tons each per hour in the two end compartments.

The designed weight of the completed hull of the *Dahlgren* class was 44.55 tons, and the designed weight of the machinery with water was 78.20 tons. The trial load specified was 20.29 tons, and this weight included 7.06 tons of equipment and 9 tons of coal, the remainder being ordnance weight.

These vessels have been designed to have a radius of action of about 1,500 nautical miles at a speed of 14 knots. They have, as before mentioned, a total bunker capacity of 32 tons, and they will probably burn about 630 lbs. of coal per hour at their cruising speed. The *Dahlgren* and the *T. A. M. Craven* are of about the same size as the U. S. torpedo-boats *Foote, Rodgers* and *Winslow,* designed four years ago by the Navy Department. It will be interesting to note, however, that whereas the vessels of the *Foote* class have machinery of about 2,000 I. H. P., the vessels of the *Dahlgren* class are fitted with machinery capable of indicating at least 4,200 I. H. P. on the same displacement—a truly remarkable difference. This great difference in power accounts for the speed raising from 24 1-2 knots in vessels of the *Foote* class to 30 1-2 knots in vessels of the *Dahlgren* class, a difference of six knots. As before stated, the Bath Iron Works have guaranteed a speed of 30 1-2 knots on these vessels, this speed being the highest ever guaranteed on any vessel of the size carrying the usual torpedo-boat trial load. It will be interesting to note also that British 30-knot boats have a displacement of 275 to 325 tons, and all the American 30-knot boats, with the exception of the *Dahlgren* and her sister, have displacements varying from 250 to 450 tons. The *Dahlgren* and *T. A. M. Craven* will be given their official speed tests during the present summer, and the builders are confident that these vessels will soon be recognized as the fastest vessels of their size and type afloat.



THREE CYLINDER TRIPLE EXPANSION ENGINES OF U. S. TWIN SCREW TORPEDO BOAT DAHLGREN—EACH 2,100 I. H. P.

RECENT EUROPEAN ICE BREAKING STEAMERS AND THEIR PERFORMANCES.*

BY H. E. SWAN.

There can be no doubt that the employment of ice-breakers is destined to become a very important factor in connection with steam navigation generally, and that many ports which formerly were partially, and others entirely, closed during the whole of the winter, will become available for commerce all the year round. The first record that we have of an ice-breaker is the *Pilot,* belonging to the port of Cronstadt. She was a small single-screw tug, with very sharp lines and great rise of floor. Her owner, the Russian merchant Britneff, conceived the idea that such a vessel could be utilized for ice-breaking, and therefore had her bow altered so that she could be forced up on to the ice, which was then broken by her weight, and although owing to the smallness of the vessel she could only deal with ice of comparatively small thickness, she embodied the germ of the idea which was destined to have important developments.

The Hamburg authorities, having heard of the *Pilot's* success, decided to have ice-breakers specially constructed for service on the Elbe, the first being *Eisbrecher I.,* built in 1871, and of 600 indicated horse power. From time to time the size and power of these vessels was increased, and their success was such that ice-breakers have now come to be looked upon as a regular part of the harbor equipment, and are able to keep the navigation open throughout the winter. In the meantime, various Scandinavian countries with ice-bound harbors had turned their attention to the subject, and a number of vessels, both to be used as ice-breakers pure and simple and also as ice-breaking ferry steamers, were built, some being propelled by paddles and others by screw propellers both of the single and twin description.

Particulars of these vessels are given in the paper[1] which Captain Tuxen, of the Royal Danish Navy, read at the International Congress of Naval Architects, held in London in July, 1897, and the illustration which he gave of the *Sleipner,* belonging to the port of Copenhagen, of 1,400 tons displacement and 2,600 indicated horse power, is a fair representation of the type of ice-breaker in use up to that time; a main feature being the cutting away of the forefoot from a point on the stem above the water line in a slanting direction, and striking the keel line about one-fourth of the vessel's length from the bow, this form naturally facilitating the mounting of the vessel on to the ice field.

Our enterprising friends, the Americans, had for some time been using ferry steamers so constructed as to be able to make their way through ice of considerable thickness, and they accidentally discovered that a single-screw steamer of this type, when leaving an ice-bound wharf, was able to make her way out better by going astern than ahead, as the disturbance of the water by the propeller had a disrupting influence of a much more important character than might have been supposed. The idea thus given was immediately taken advantage of and embodied in the next vessels to be built, which were given the bow propeller, the first to be so fitted being the *St. Marie,*[2] built in 1893, for service on the great lakes. Experience with the latest ice-breakers so constructed has proved that not only is the bow propeller very valuable, but it is almost indispensable where heavy packs of ice have to be dealt with. With the exception of some of the American vesels, which were built of wood, the whole of the others have been built of iron or steel, of which latter material all the more recent vessels have been constructed.

It would be impossible in the limits of a paper of this description to give many details as regards the construction of such vessels. It will, however, be interesting to the members if I give a few particulars of two vessels built last year, embodying all the latest practice, and which have been at work during the past winter with eminent success. These vessels were the *Sampo,* of 2,000 tons displacement and 3,000 indicated horse power, built for the Finnish Government, and the *Ermack,*[3] of 8,000 tons displacement and 10,000 indicated horse power, built for the Imperial Russian Government. The *Sampo* has one single propeller aft and another one forward, and her chief dimensions are: Length, 202 ft.; beam, 43 ft.; depth to upper deck, 29 ft. 5 in. Her bow and stern have considerable overhang, the contour being such as to strike the ice at a very acute angle, so that when the vessel is driven with considerable force she has a tendency to rise on the ice in a slanting position, which, while it conduces to bringing her maximum weight to bear, does so in a manner which mitigates the blow to the vessel herself.

The *Ermack* marks an immense stride in the construction of ice-breakers, being fully three times as powerful as any vessel previously constructed; moreover, she has four propellers, three placed aft and one forward. Her principal dimensions are: Length over all, 305 ft.; beam, 71 ft.; depth to upper deck, 42 ft. 6 in.; the contour of her bow and stern also shows a quite exceptional amount of overhang, and both she and the *Sampo* had their sides inclined outwards at a considerable angle from the vertical, to lessen the strain when the vessels are being nipped in the ice floes. The whole construction of the *Ermack* is exceedingly strong, and she is subdivided into forty-eight compartments, the water-tightness of which has been tested in the most efficient manner; and as an example it may be mentioned that after the vessel was launched, and her engines and boilers fitted on board and all complete, one of the boiler-rooms was filled with water to the upper deck, the bulkheads practically showing no deflection. This is probably the most severe test to which the bulkheads of any ship have ever been previously subjected, and as the other parts of the hull are relatively as strong, this gives a good indication of the vessel's solidity. The frames are placed 12 in. apart, and the thickness of the ice belt varies from 1 1-4 in. at the ends, where most of the ice-

*A paper read before the Institution of Naval Architects, England.

1 This paper was published, with engravings, in our issue of September, 1897.

2 This statement is inaccurate. The first steamer of this type was the *St. Ignace*, 1,200 gross tons, built by the Detroit Dry Dock Co. in 1888, for service in the Straits of Mackinaw. She is fitted with a propeller at the bow of smaller dimensions than that at the stern. For a more complete description of this vessel see the issue of April, 1898.—Ed. M. E.

3 For engraving of this vessel see issue of February, 1899.

breaking is to be done, and is slightly reduced in other parts less exposed to shocks when breaking ice.

In ice-breakers generally it is highly important to have a model of a rounded form, and to have the outside surfaces as smooth as possible, both seams and butts for this reason being flush plated. It is desirable also that the vessels relatively should be short and broad, as this is found to greatly assist their manœuvring in ice, and prevents the broken pieces from clinging to the shell plating. It is also important to have the pumps of enormous power, connected with trimming tanks both at the bow and stern, and also at the sides of the ship, so that if the vessel gets caught in the ice her horizontal plane may be varied in any sense desired, whereby she can the more readily release herself.

Experience with the *Sampo* and *Ermack* has shown that pack ice of practically any thickness can be negotiated; and in the case of the latter vessel, she on one occasion encountered a pack which was measured and found to be of a total thickness of 34 ft., 9 ft. being above the level of the field, and through which she successfully forced her way—a feat which would have been quite impossible but for the action of the forward propeller. As regards the propellers themselves, I may mention that we have made them both of bronze and of nickel steel, and have not so far had a broken blade, and this in spite of the fact that on many occasions the engines have brought up "all standing," which, I need hardly say, requires their being designed in all their working parts, both as regards scantlings and surfaces, on a basis greatly in excess of what is usual in machinery for ordinary purposes. In operation the *Ermack* has broken composed ice of 8 ft. 3 in. in thickness, and she has gone through field ice of about 40 in., with 6 in. of snow upon it, at a speed of 2 1-2 to 3 knots; moreover, she has been driven at a speed of about 10 knots through clear ice of 24 in., whilst ice under 18 in. has little effect upon her. It is found that snow has a wonderfully great retarding influence upon an ice-breaker, much more so than a similar thickness of solid ice.

Manœuvering powers of the *Ermack* are remarkable, seeing that with her helm only she can turn in a circle of only twice her own length, and her handiness was specially shown when she entered the frozen-up port of Cronstadt on March 16 last, proceeding without stopping through an entrance only 95 ft. wide and berthing herself alongside the quay without assistance, whereas under ordinary circumstances of navigation in open water steamers are in the habit of being assisted by tug-boats.

Her practical utility was not long in being put to the test. Immediately on her arrival urgent word was received from Reval that a number of steamers were in great jeopardy; she at once proceeded there, and was the means of liberating thirty-three steamers of an aggregate value of $7,500,000. She subsequently returned to Cronstadt and St. Petersburg, and was instrumental in relieving and facilitating the entry of some forty more steamers several weeks earlier than if they had waited the ordinary opening of navigation. This performance is a very conclusive proof of the commercial value of such a vessel. When a passage has once been broken, vessels of ordinary construction can usually follow in the channel thus made without suffering injury; where, however, vessels are intended to work regularly in this way, it would be advisable to give them a little additional strengthening, especially as regards the bow, and as regards the propeller, this had better be of steel somewhat stronger than ordinary practice.

It is necessary here to point out that all of the foregoing remarks apply to ice-breaking in the Baltic, or where the ice is formed gradually at moderate temperatures, and that the same result could not be looked for in the case of service in the Arctic regions, where the ice is of a much harder and more brittle description, and it probably would not be prudent to have the bow propeller shipped when a vessel is employed among the heavy ice of the Polar seas.

In connection with the *Ermack* I must not fail to mention the name of Vice-Admiral Makaroff, of the Imperial Russian Navy, but for whose personal initiative this important vessel would never have been built, and from whom we received very much valuable assistance during the vessel's construction.

A very important application of ice-breaking steamers is shown in their ability to form connecting links in railway systems in crossing large stretches of water—which it would be either impossible or too costly to bridge—and of which we ourselves have had two notable examples. Near the town of Saratoff, on the river Volga, there is an important railway traffic, which during the winter was practically suspended, and could only be carried on in a desultory way when the ice was strong enough to bear sledge traffic; but there were occasions both in the spring and autumn when communication, either by sledge or navigation, was absolutely impossible. In this case there was a further difficulty in the large range in the depth of water; it sometimes was as low as 10 ft.; but with the melting snows in spring the water rose to the extent of 45 ft. It became necessary to design a vessel which could not only contend with the ice but load and discharge the freight cars at varying heights. We therefore proposed a twin-screw vessel of the following dimensions: Length, 252 ft.; breadth, 55 ft. 6 in.; depth, 14 ft. 6 in. This vessel has four lines of rails, each pair converging into two hydraulic lifts placed side by side at the bow of the vessel, and it is found in practice that the full load of twenty-four cars can be run off or on to the shore in half an hour, and this at varying heights according to the depth of the water. Owing to the limited draught of the water it was not possible to give this vessel the necessary form to break the heaviest ice, the thickness sometimes being as much as 3 ft.; she, therefore, under these circumstances, works in conjunction with a twin-screw ice-breaker of the ordinary type of 870 tons displacement and 1,500 indicated horse power; but when the ice is of moderate thickness, say about 20 in., the ferry-boat is able to work without assistance. These vessels have now been at work for three seasons, and have maintained the railway service without a single day's interruption.

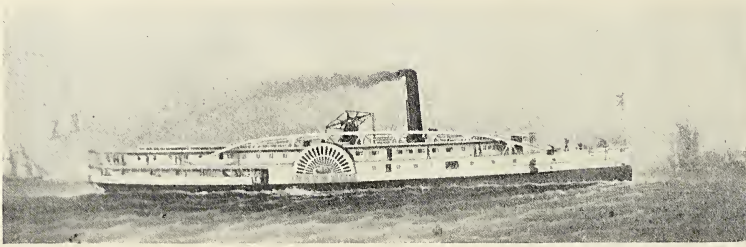
The other important ferry ice-breaker is that which is now being erected on the shores of Lake Baikal, and which, when completed, will form an important connecting link in the great Siberian railroad, the lake at the point in question being forty miles wide. This vessel has a displacement of 4,200 tons, is 290 ft. long, 57 ft. beam, and 28 ft. 6 in. deep to the rail deck. She is fitted with three sets of engines of an aggregate power of 4,000 horses, two sets being placed aft, driving twin-screw propellers, the third set being at the bow. This vessel

has three lines of rail laid on her deck, but as the height of water in the lake does not materially vary, connection with the shore can be made by a movable gangway. As the weather in the lake at times is very stormy, it is found desirable that the carriages should be under cover; therefore the vessel is built with a closed superstructure which gives her very much the appearance of the American lake steamers. In the superstructure is also provided very extensive accommodations for the passengers, who will find it more convenient than being cooped up in the railway carriages during transit. The construction of this vessel marks a record in shipbuilding; the vessel, after being erected in our yard on the Tyne, was taken to pieces, shipped to St. Petersburg, and thence taken a distance of about 5,000 miles overland to the shores of Lake Baikal, which would have been difficult enough had there been railway transit the whole distance, whereas a considerable portion of the road had to be covered by sledge, and this, considering the great weight of parts of the machinery, and including as it did her fifteen main boilers, was a task of some difficulty. The vessel is to be launched this summer and to be ready for next season.

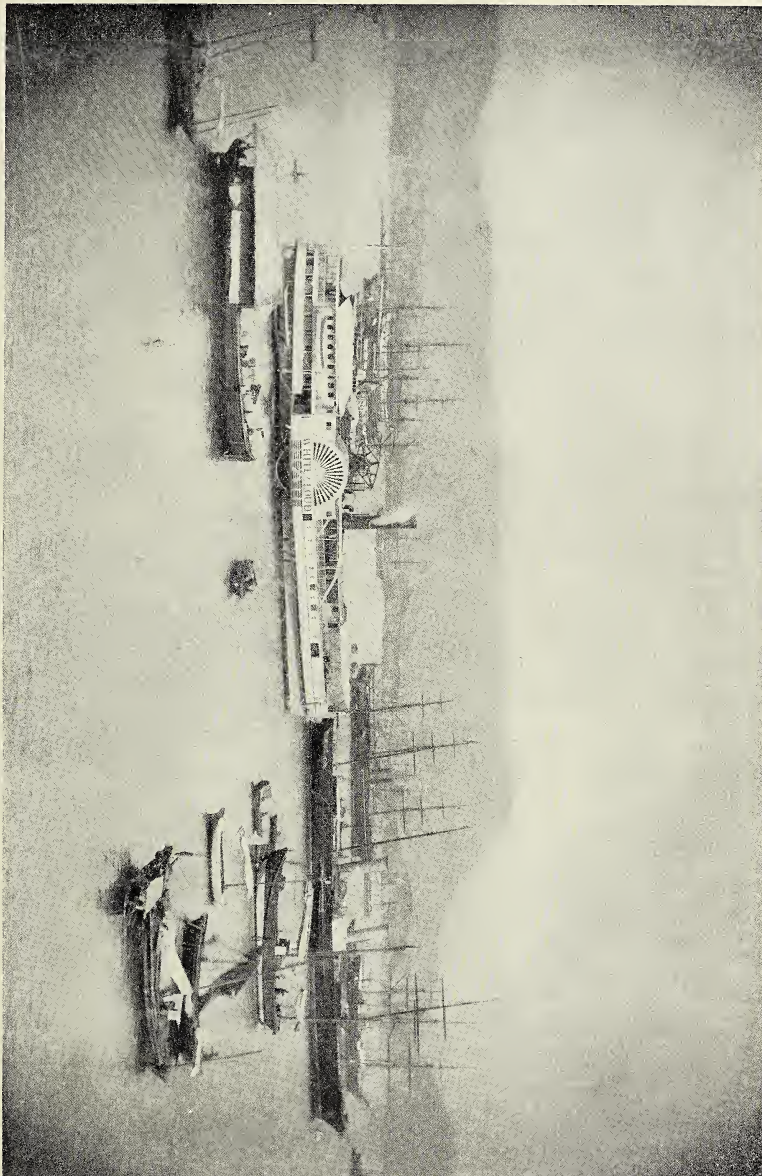
In conclusion, I can only reiterate my belief that the employment of ice-breaking vessels has not yet reached anything like the importance that it will yet achieve, and that still more important developments in this class of vessel may be expected in the future.

AMERICAN SIDEWHEELERS SENT TO CHINA UNDER THEIR OWN STEAM.

From time to time recently there has been much comment in the technical papers of various countries on the successful ocean voyages of war vessels of different classes. Much credit, for example, was recently claimed for the German built torpedo boat destroyers that steamed from the North Sea to China successfully. About the same time much credit was claimed, also, for the work of the British builder, whose torpedo boat destroyers made the voyage to Japan under their own steam. These and similar performances, indeed, have been generally considered as extraordinary. In view of the fact that this style of craft is built for sea service, and ought to be able to make long trips at reduced speed, it is rather difficult to understand why surprise should be expressed when such boats actually do what they were intended to do, or perform services similar to that which they may be called upon to perform in time of war. The trip of the battleship *Oregon* from the Pacific to the Atlantic coast at the beginning of the Spanish war produced, what is familiarly called, a "profound impression" in naval circles generally, though among members of the merchant marine the real grounds for such wonderment was not so clearly seen, when comparisons were made with the regular work of merchant steamers—taking into con-



AMERICAN SIDEWHEELERS KIN KIANG AND PLYMOUTH ROCK, THAT STEAMED FROM NEW YORK TO CHINA.
Original photographs by Pun Lun, Queen's Road, Hong Kong, China.



AMERICAN SIDEWHEEL STEAMER WHITE CLOUD, IN THE PORT OF HONG KONG, CHINA, JUNE, 1859, AFTER MAKING THE TRIP FROM NEW YORK UNDER HER OWN STEAM.

Photograph by kind permission of Captain Samuel Newton, retired.

sideration, of course, the size and power of the war vessel.

If the performances of these various vessels and their crews are so meritorious, what credit must be due the men who built and manned the boats that steamed unaided from the port of New York to the Pacific coast and Asiatic ports many years ago?

The *City of Kingston*, a small Hudson River propeller with light wooden upper works, was bought by a Pacific coast concern several years ago. She left New York under her own steam, went south and through the Straits of Magellan and up along the Pacific coast to Puget Sound, making stops for coal on the way—in fact, making a slightly longer trip than the famous trip of the *Oregon*, only in the opposite direction. Taking into consideration the size and light build of the boat, her performance was actually deserving of great credit.

The Hudson River sidewheel beam engine steamboat, with its wooden hull, overhanging guards and light wooden superstructure would hardly be classed, nowadays, as a seagoing type. Between forty and fifty years ago, however, a number of such boats were built in New York for river service in the Chinese Empire, and they invariably made the run out under their own steam without serious mishap. This style of boat has undergone little change in later years, and is still fitted with leg boilers, working at 45 to 50 lbs. pressure, and simple engines with single cylinders. The only improvement over the old styles is in the size and construction of the paddle wheels. Of the boats that went to China several had wheels with iron arms. At the time these boats went out the Suez Canal was not in existence, and so the usual course was around the Cape of Good Hope.

One of the first American boats for Chinese waters was the *Confucius*, ordered in New York by Russell & Co., of Hong Kong, in 1849. The hull was constructed by Thomas Colyer, and the engine by H. R. Dunham. The steam cylinder was 50 in. dia. and 120 in. stroke. This boat arrived out safely, and though built for freight and passenger service, was afterwards purchased by the Chinese Government and converted into a gunboat. After the sale of the *Confucius* the owners ordered another boat here to take her place. This was the *River Bird*, which went out in 1856. After a short career as a merchant vessel the *River Bird* was chartered by the British Government, during the Indian mutiny, to convey troops for the relief of Lucknow, and she was wrecked in the Hooghly River in 1857. Subsequently Russell & Co. placed an order here for a third vessel to replace the *River Bird*, and this boat when built was named the *White Cloud*. This vessel, also built by Thomas Colyer, was 175 ft. long, and was fitted with a beam engine with cylinder 44 in. dia. and 120 in. stroke, built by the Morgan Iron Works. In the accompanying large engraving the *White Cloud* will be seen lying at the port of Hong Kong on her arrival out in June, 1859. This is a reproduction of a photograph taken at the time, and which from age has become rather indistinct. The run of the *White Cloud* to China was made on a reduced coal consumption, as coaling stations were few and far between, and as a precaution two small masts were fitted so that sail power could be used in case of necessity. At each coaling station a stop of several days was made to enable the crew to make a few slight repairs.

A short abstract of the log of the *White Cloud* on this remarkable voyage will be of interest:

Left New York March 2, 1859. Captain, Josiah Paul; Chief Engineer, Samuel Newton.

Arrived at St. Vincent, Cape Verde Islands, West Coast of Africa, in 17 days. Distance run, 2,919 miles. Coaled.

Left for Cape of Good Hope and arrived in 23 days 12 hours. Distance, 3,896 miles. Coaled.

Left for Point de Galle, Island of Ceylon, and arrived in 24 days. Distance, 4,380 miles. Coaled.

Sailed for Hong Kong, stopping at Singapore, and dropped anchor in Hong Kong harbor June 7, 1859. Distance 3,000 miles.

Total distance from New York, 14,195 miles.

The crew of the *White Cloud* celebrated the Fourth of July, 1859, by running the trial trip on the Canton River. This was entirely satisfactory and the boat was put in service between Hong Kong and Canton, and subsequently between Hong Kong and Macao. After twelve years of good service she was lost in a typhoon in Macao harbor. As may be noticed in the engraving, the *White Cloud* was fitted with a small gun, as pirates frequented the Chinese waters.

Another steamboat, the *Plymouth Rock*, built in 1863, left New York in September, 1864, and steamed to China, where she plied on the Canton River. Later she was put on a route on the Yang Zee River, trading between Shanghai and Hankow. Her name when launched was *Foong Suey*, but this was changed to *Plymouth Rock* on arrival out at China. Later several other boats were built for service in Chinese waters. One of these was the *Nantilus*, built by Fletcher, Harrison & Co., in 1866. Her engine was a duplicate of that originally fitted in the famous Hudson River passenger steamer *Mary Powell*. The steam cylinder was 62 in. dia. and 120 in. stroke.

S. S. Kinfauns Castle.—As an instance of the increasing dimensions of liners on long ocean routes, the *Kinfauns Castle*, building on the Clyde for the Cape Mail Service, is an interesting vessel. Her dimensions are: Length, over all, 532 ft. 3 in.; beam, extreme, 59 ft. 3 in.; depth, moulded, 38 ft. 9 in.; gross tonnage, 9,700 tons, and horse power, about 10,000 indicated. The vessel will have accommodation for nearly 700 passengers of all classes. She will be fitted with twin screws, driven by quadruple expansion engines, with a working steam pressure of 210 lbs. The interior arrangements have been very carefully planned for the comfort of the passengers. There will be a very extensive equipment of electric fans, and the refrigerating apparatus will also be very extensive, cool drinking water being supplied at many points in the living quarters. The evaporating plant will have a capacity of 13,000 gallons of drinking water a day, and all the water will be carefully filtered in the most scientific method. Loud speaking telephones are fitted between the working stations above deck and the engine room and the tiller room aft.

Mishaps to war vessels undei steam do not appear to be confined to the American Navy. A recent report from England gives particulars of a collision between the battleship *Sans Pareil*, 10,500 tons, and the full rigged ship *East Lothian*, off the Lizard. The ship sank and one man was drowned.

CONSIDERATION OF THE INDICATOR AND ITS USES ON BOARD SHIP—VII.*

BY R. W. JACK.

(Concluding Chapter.)

The lead line is a continuation of the compression curve, and is usually obtained by an additional angular advance of the eccentric sheave. The point of opening to steam is, therefore, fixed in the first instance by this consideration, and it may be altered only by changing the position of eccentric sheave, the travel of the valve, or the outside lap. The effect on the lead produced by linking depends upon whether the eccentric rods are open or crossed when the crank is on the bottom center. The rods are said to be crossed when they occupy the position shown in Fig. 17, and to be open as in Fig. 18.

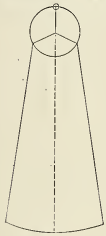


FIG. 18.

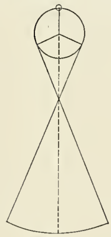


FIG. 17.

With open rods the effect of linking up is to increase the lead, while with crossed rods the reverse is the case, the lead is reduced.

Generally speaking, in the matter of indicator diagrams we may be permitted to say that the more nearly we can obtain an approach to the ideal conditions the more usefully will the steam be employed. To bring those conditions to mind we might just recapitulate them in order, viz.: First. Waste steam space or total clearance at the ends of cylinder should be as small as possible. This space evidently depends upon the area of the steam passages, the distance between the valve face and cylinder, and the actual clearance allowed to the piston. For any given diameters of cylinders the ratio will be nearly the same, but as the effect of clearance upon the expansion curve depends upon the proportion the clearance bears to the volume of cylinder, or rather to that portion of it filled with live steam, it will be seen that the longer the stroke of the engine and the further steam is carried, the less cause there will be to consider this defect. Second. The pressure of steam in cylinder should coincide with that in the steam chest till the point of cut-off. The steam line of a diagram is in fact the result of a compromise between a more correct line obtained by a certain area of valve with sufficient travel, and the practical drawbacks of excessive friction in the case of a common flat side valve. Third. The expansion curve should not be interfered with by a leaky piston or valve. All that can be done to improve the curve is in the direction of improving the mechanical condition of the engines in the matter of ensuring absolute steam-tightness of piston and valve, whilst regard should also be paid to the efficiency of the non-conducting arrangement of the body of the cylinder. Fourth. The exhaust should not take place till near the end of the stroke, and should instantly fall to the mean back pressure. The exhaust may be made to take place early or late, as we have seen, but its position in practice depends upon the amount of compression to be allowed. Fifth. The back pressure should be fairly uniform. Perfect uniformity of back pressure is possible only when the ratio of influx and efflux of the steam are equal, but a slight variation is of little consequence. Sixth. The compression should not be excessive. The compression in a cylinder, so far as it is possible for us to deal with it, without at the same time creating an objectionable feature at the moment of opening to exhaust, should be so adjusted as not to exceed all that is found necessary to the smooth working of the engines, and this should be attained by a moderate rise of the curve. Compression in a cylinder carried beyond this limit is produced at the expense of causing a reduction of area of the diagram representing actual work, and though this is not theoretically a loss, it is to be expected that besides conducing to liquefaction of the steam the tendency to leakage is also aggravated. A certain amount of compression, however, compensates the evil of necessarily filling the passage and clearance in the cylinder with live steam.

The behavior of the steam during the entire interval of its passage through the cylinders may be exhibited by combining the cards taken from each engine in series. This is effected by drawing each diagram to the same scale, both as regards pressures and volumes. The following instructions should now make themselves clear: Take the three sets of cards shown in Fig. 19

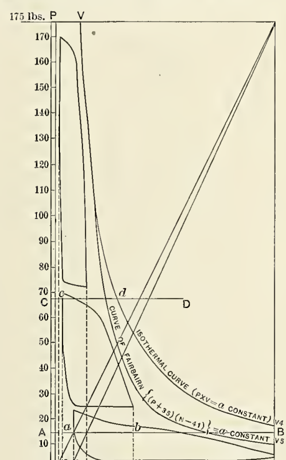
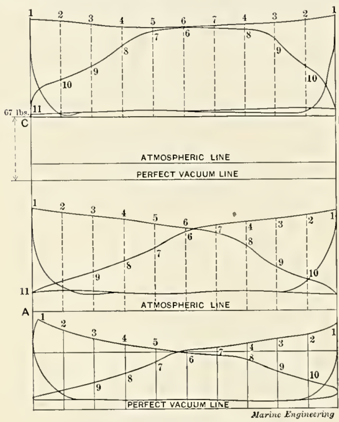


FIG. 19.

(Page 112) from a triple compound engine. Divide each of the cards in the usual way into 10 equi-distant divisions, and choose any convenient scale to measure volumes and pressures. For simplicity, we will use the scale of pressures to which the L P diagram is drawn. It should also be distinctly un-

*From a paper read before the Institution of Engineers and Shipbuilders at Hong Kong.

derstood that we deal only in absolute pressures, *i. e.*, gauge pressure, plus 15. Draw two lines $O\ P$ and $O\ V_3$ at right angles to represent the lines of pressure and volume respectively. The point O will be the starting point or zero of both. We will suppose for the purpose of illustration, though it should be approximately ascertained, the mean clearance or idle space of each end of the cylinders to be $\frac{1}{10}$ of the space swept by the piston, and which will, therefore, be also represented by $\frac{1}{10}$ of the length of each indicator card. From the point O, lay off $Ov_3 = \frac{1}{10}\ v_3\ V_3$—, and proceed to draw in the L P indicator card as taken from the cylinder taking the mean pressure of both ends, *i. e.*, the mean of the pressures 1 and 1, 2 and 2, etc. The scale to which the pressures of the L P card are drawn is $\frac{1}{16}$ in. to 1 lb. It will be more convenient in marking off the pressures on the M P card to measure from a horizontal line drawn just below the back pressure line at a fixed distance from the base $O\ V_3$; thus we will, therefore, take the pressures on this card from the atmospheric line $A\ B$. The scale to which the indicator diagram of the M P engine is drawn is $\frac{1}{32}$ in. to 1 lb. To enlarge this dia-



SEPARATE DIAGRAMS OF FIG. 19.

gram to the same scale as the L P we must, therefore, multiply each pressure by $\frac{32}{16}$ or 2. Again, the distance Ov_2 is equal to $\frac{1}{10}$ of the distance $v_2\ V_2$, where $v_2\ V_2$ equals the length of the M P, supposing it to have an area equal to that of the L P cylinder. In other words,

$$v_2\ V_2 = \frac{\textit{Volume of M P cylinder}}{\textit{Area of L P cylinder}} \text{ or}$$

$$\frac{\textit{Diameter of M P cylinders}^2 \times \textit{Length of stroke}}{\textit{Diameter of L P cylinder}^2}$$

where the length of stroke is equal to the length of L P, *i. e.*, the distance $v_3 V_3$. Divide the distance $v_2 V_2$ or $a\ b$ into 10 equal parts exactly as in the full-sized card and mark off the pressures from the line $A\ B$, in every case using the mean of those pressures which are at equal distance from each end of the indicator card. The figure drawn through those points will represent the M P indicator card to the same scale as that to which the L P is drawn, and it, therefore, should be merely a continuation of the L P curve following the laws of expansion or compression. The same construction holds for any number of cylinders in series. Ov_1 is the mean clearance of the H P cylinder, and is equal to $\frac{1}{10}$ of $v_1\ V_1$. The length $v_1\ V_1$ represents the volume of the H P cylinder compared with the L P, and, as before,

$$\text{is equal to } \frac{\textit{Diameter of H P cylinder}^2 \times \textit{stroke}}{\textit{Diameter of L P cylinders}^2}. \text{ Again}$$

draw the line $C\ D$ parallel to the base, and at a distance from it which will suit our convenience in laying off the pressures on the 10 equi-distant ordinates. In this case we have drawn it 67 lbs. from the base $O\ V_3$. The scale to which the H P cylinder diagram has been traced is $\frac{1}{64}$ in. per lb., so that to make the pressure correspond to a scale of $\frac{1}{16}$ per 1 lb. we must multiply each mean pressure taken from the card by $\frac{64}{16}$ or 4, and lay them off on the new ordinates raised from the base line $C\ D$. Trace the figure through those points on the ordinates which shall show H P cylinder diagram to the same scale as the L P and M P engine diagrams.

It will be interesting now to draw the ideal or hyperbolic curve, when it will become clearly apparent where the varied actions of liquefaction and re-evaporation of the steam take place and to what extent. For this purpose it may be best to take the actual point of cut-off in the H P cylinder and suppose that the boiler pressure is fully maintained up to that moment. The indicator card may show the steam to be somewhat wire-drawn, but it must be remembered that a certain amount of liquefaction almost invariably takes place during the same interval, so that we may safely assume for present purposes that the quantity of steam expanding throughout the cylinders is that represented by the volume which is occupied by the steam (not including the clearance) at the point of cut-off in the H P cylinder, and at a density due to the full boiler pressure. Assuming, then, the pressure to be equal to $O\ P$ and the volume to be $P\ V$, the curve $V\ V_4$ is drawn according to the directions already given. The combined card is frequently compared with the curve of saturated steam drawn to Tate's formula of $(P + .36)\ (V - .41) =$ a constant, and in this case the possibilities of improvement are indicated by the spaces which the combined cards fail to fill. It has, too, been shown how this construction, which is merely a hyperbolic curve drawn from a point found by the formula, is effected, and the efficiency of steam-jacketing is decided by the balance of power gained in comparison with that which is lost by condensation in the jacket.

There are many other interesting experiments which may be effected by the aid of the indicator, for its utility is not confined merely to its application to the steam cylinders of an engine, but may be extended to any chamber or receptacle for the measurement of pressure, either constant or variable. It is sometimes required to ascertain the distribution of steam in a cylinder in relation to the position of the slide valve, and for this purpose the motion must be taken direct from the motion of the valve itself. The eccentric revolving, as it does, in the same direction as the crank, the various positions may be judged accordingly. In an ordinary diagram the points where the valve closes to exhaust, and where it opens to steam, are often very indefinite, owing to the slowness of the motion of the piston, while if the motion of the indicator barrel be taken from an engine attached to the same shaft, but whose crank is

set at an angle to that of the engine with which the cylinder of the indicator is in communication, the relative movements at those points (compression and lead)

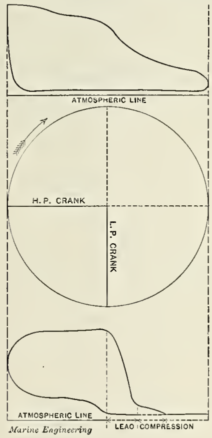


FIG. 20.

are accelerated as a result of the relative positions of the two cranks. The purposes for which this arrangement is primarily useful are a more exact determination of

FIG. 21.

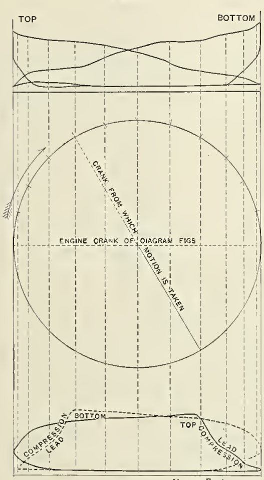


FIG. 22.

the extent and value of the lead opening and the curve of compression. Suppose, for instance, that the indicator is attached to the H P cylinder of a compound engine, and the motion of the paper drum taken from the L P crosshead. Then the diagram taken under those conditions would be something like that shown in Fig. 20. The direction of revolution is coincident, but the L P crank following at an angle of 90° alters the various points on the diagram. The curves also become deformed, and their extent in the length of the diagram is diminished or increased according to the relative velocities of the two pistons, but our object of clearly showing the periods of compression and admission of steam is attained, and the accuracy of the setting of the valve more easily defined, as far as those two critical points are concerned. The two diagrams shown in Figs. 21-22 are actual examples of diagrams taken under the two different conditions. Fig. 21 is the diagram taken in the usual way, and Fig. 22 is a diagram taken from the same cylinder, but the motion of the paper is taken from an engine whose crank is set at an angle of 120 deg. behind the crank of the engine which we are considering. With a little thought the figure explains itself.

The indicator may usefully be applied to pumps of all descriptions either for the purpose of calculating the

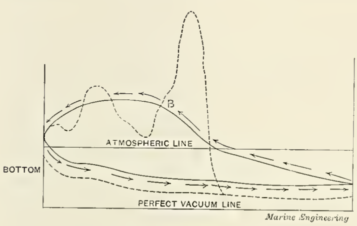


FIG. 23.

power required to work them or to detect any abnormal conditions which may interfere with their efficient and smooth working. But I suspect that I have already encroached upon the limits which might well be set to papers of this description, and I beg simply to append a few diagrams from pumps, with short explanatory notes. The diagram marked Fig. 23 is one taken from the bottom end of a vertical, double-acting circulating pump. The diagram which is shown in full lines is taken under normal conditions of work with engines running at 120 revolutions per minute. The arrow-heads show the direction of motion, and the ends of the stroke are marked top and bottom. This card is taken with a L P spring, and it will be noticed that it is almost exactly a counterpart to that which we might expect from a L P cylinder, the only difference being that it is reversed; that is, compression takes the place of expansion. Beginning at *A* when the plunger is on the top, the air which has been drawn in through the pet valve is compressed until the pressure rises sufficiently to overcome the resistance due to the head of water above the discharge valve on the ship's side, and the friction of the water through condenser tubes, etc. At the point *B* the pressure has attained its maximum when the resistance offered by the flow of water is exactly balanced by the pressure in the pump chamber. Towards the end of the stroke the pres-

sure falls partly on account of leakage and probably in part due to the retarded motion. When the plunger reaches the bottom end of its stroke the pressure falls somewhat gradually, owing to a small amount of confined air, but during the return stroke the pressure in the chamber diminishes until the plunger arrives at the point whence we started. The figure shown in dotted lines is a diagram taken from the same pump representing the effect of closing the pet valve. It will be observed that in this case there is little or no compression curve, and that the plunger strikes the inert body of water almost solidly with considerable force, so that the inertia of the water causes a momentary resistance far in excess of the normal working conditions. On the return stroke it may also be noticed that the vacuum

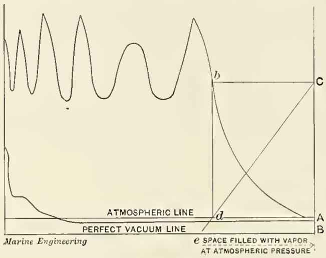


FIG. 24.

formed on the same side is more complete, but the danger of entirely excluding air from the pump chamber will be readily recognized and valued by practical engineers.

Diagram, Fig. 24, is taken from the feed pump of the same engine with the pet valve just slightly open, working at the same speed against a boiler pressure of 150 lbs. per sq. in. The compression curve is fairly uniform, and the immediate rise shows that the air admitted occupies very little space. By describing a parallelogram round the two extreme points of the curve *a* and *b* we may roughly locate the origin of the curve, and thereby estimate the space which the air at atmospheric pressure occupies in the length of the pump barrel when the ram

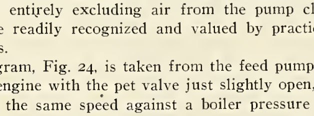


FIG. 25.

begins the down stroke. The efficiency of the pump seems to be well maintained, being nearly two-thirds of the stroke, or 66 per cent. The serrated line of pressure is probably due to the sudden opening of the check valve, the speed of the ram, which is direct acting, traveling at a mean velocity of 480 ft. per minute, and in part to the unsuitability of the indicator itself, which was a Richards. The temperature of the feed water at this point was 152° F., and this fact doubtless accounts for the small amount of vacuum shown on the up-stroke.

Diagram Fig. 25 is that from the bottom of an air pump having three sets of valves. It shows how really little there is for this pump to do after attaining a working vacuum; but having to deal with a highly attenuated vapor, only a pump of large capacity could efficiently dispose of it.

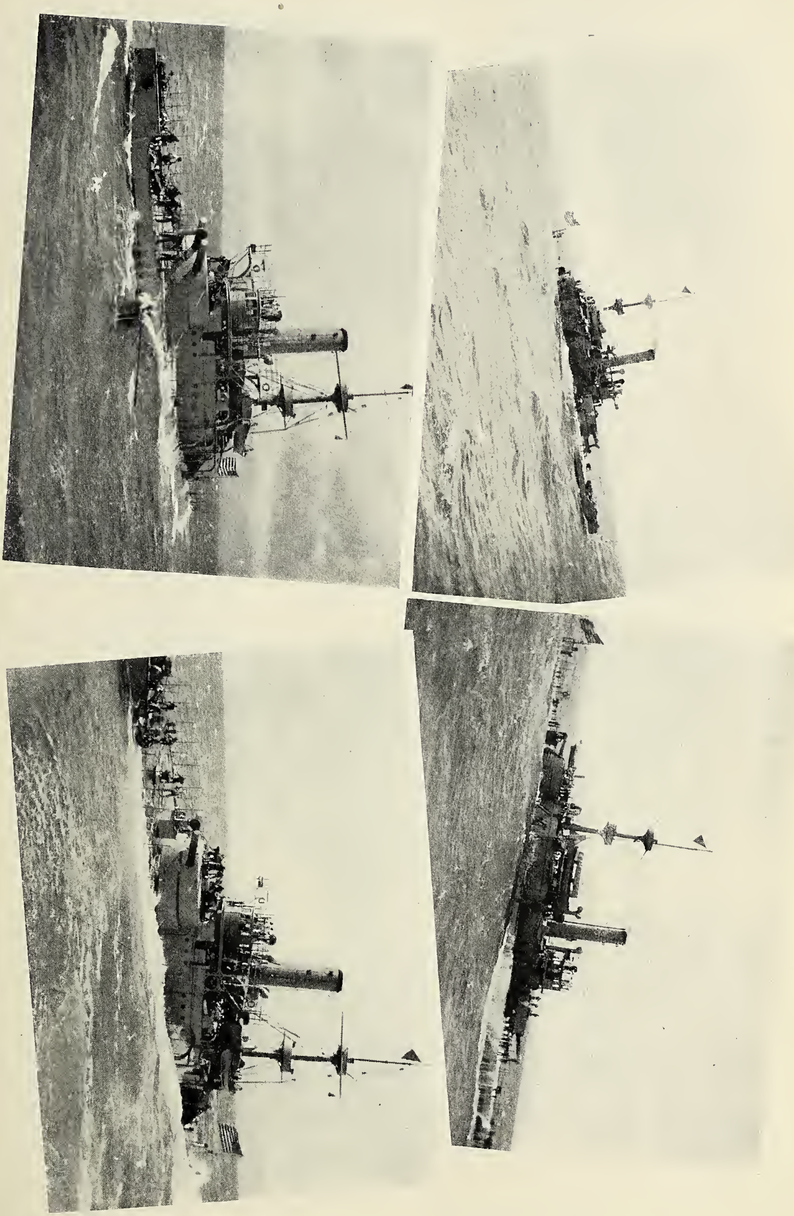
I should state in explanation that the object of the present paper has been to present to the members of this institute a summary of the principles upon which the economic value of steam depends, and to trace the connection between the simple laws of expansion, as illustrated by an ordinary diagram, and the modifications involved in practice, rather than simply to record the conditions which accompany or account for the peculiarities of indicator diagrams. I have adopted this method under the belief that those other papers which are to be read on the same subject will deal more exclusively with indicator diagrams taken from engines which are varied both as regards their design and the work which they are intended to perform.

U. S. Monitor Monadnock at Sea.

Among the heavy war vessels now on duty at Manila is the monitor *Monadnock*, which, in spite of its official designation as a "coast defense" vessel, made the trip across the Pacific without mishap and arrived out ready to do business. A very interesting set of photographs showing the behavior of this vessel at sea are reproduced on page 115. These were taken by J. T. McMillan, of the U. S. Hydrographic Office at San Francisco, who served as a volunteer naval officer in the Far East. The views were taken when the vessel was near Honolulu, in comparatively smooth water. There is no class of vessel in our Navy the usefulness of which has been the cause of more discussion than the monitor. The splendid record made by this type of ship during the Civil War made many friends for the type. During the Spanish War, however, there was much criticism of the type, it being charged that the monitors made very unstable gun platforms, and were deficient in steaming capacity at sea. The consensus of opinion among those who have to operate such vessels seems to be that they are best suited for harbor work, or as coast defense ships. Several long ocean voyages stand to the credit of the monitor type, so that whatever their effectiveness in a naval engagement at sea might be, there can be no doubt of their seaworthiness. This, of course, is quite aside from the question of comfort, etc., of those on board. Under the conditions in which the present photographs were taken the only dry spots on the vessel were the tops of the turrets and superstructure.

The *Monadnock* is an iron double-turreted vessel, in dimensions: Length, 259 ft. 6 in.; beam, 55 ft. 6 in.; draught, 14 ft. 6 in., and displacement 3,990 tons. She is fitted with twin screws and horizontal triple-expansion engines of 3,000 I. H. P., and is supposed to have a sea speed of 12 knots. The coal capacity is very limited, her bunkers holding only 250 tons. Her armament consists of four 10 in. breech loaders, two 4 in. rapid fire guns, and a variety of small rapid fire guns in her secondary battery. She is protected with varying thickness of armor, ranging from 11 1-2 in. on the barbettes down to 1 3-4 in. on the protective deck. Her original commission is dated February 20, 1896. The complement is 26 officers and 157 men.

It will be remembered that there are now under construction in private yards four harbor defense monitors, each of a normal displacement of 2,700 tons.



U. S. DOUBLE TURRETED MONITOR MONADNOCK ON HER WAY TO MANILA—PHOTOGRAPHED ON THE PACIFIC NEAR HAWAIIAN ISLANDS.

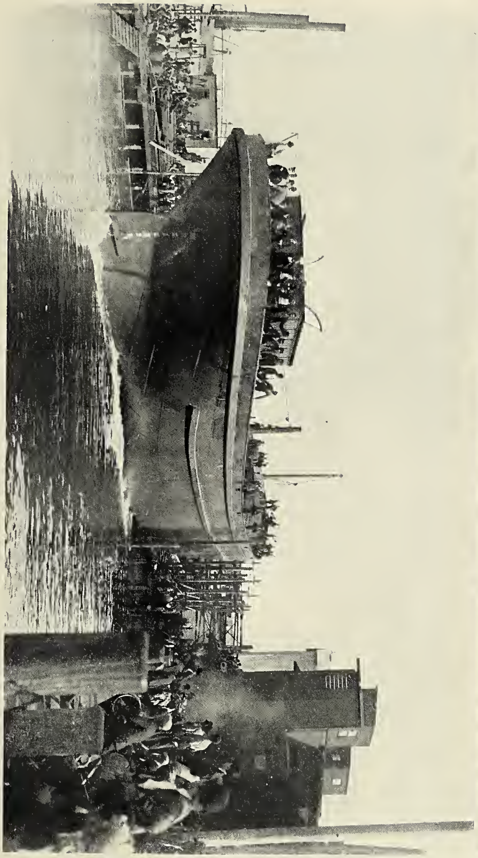
STEEL SEA-GOING TUG GYPSUM KING BUILT IN NEW YORK HARBOR.

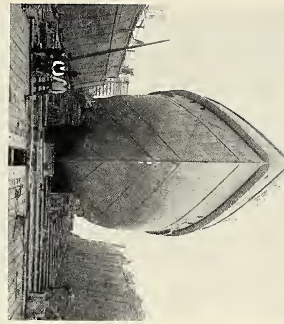
Among the steel shipbuilding plants which have recently come into existence, that of the Burlee Dry Dock Co., Port Richmond, Staten Island, is an interesting example. This concern is an extension of an old established wooden shipbuilding plant on the same site, to which was added a neighboring machine shop and the combined interests then put in a very fine plant for the construction of steel hulls and machinery. The president of the company is William J. Burlee, and the secretary and treasurer W. J. Davidson. Though the new yard has only been in operation less than a year, several highly successful vessels have been turned out. The first vessel completed was the tug *Fred. B. Dalzell*, of New York, and following this came the ocean-going tug *George's Creek*, of Baltimore, for the Consolidated Coal Co. This vessel has exceeded the contract requirements for towing and speed. Later came the *Gypsum King*, one of the largest and most powerful ocean-going tugs ever built in this country. She was built to the order of J. B. King Co., Windsor Plaster Mills, Staten Island, N. Y., for the purpose of towing barges laden with gypsum from the Bay of Fundy to the owner's works. Since she was completed the *Gypsum King* has made four round trips. The trip home with a tow occupies four days, and on each occasion she has brought more than 4,000 tons of gypsum at an average rate of speed of 9 knots, on a coal consumption of about 17 tons in 24 hours—a fine performance and one showing that the conditions of service have been very well met in the new vessel.

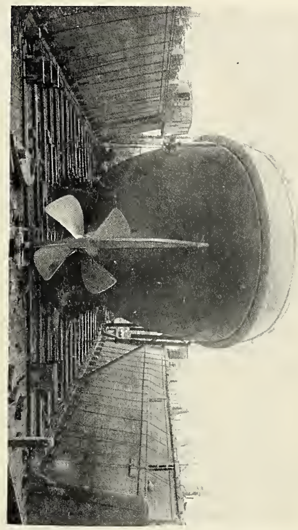
The yard also received orders for three steel barges from the same owners, each to have a capacity of 2,000 tons. One of these barges has been completed and put into commission and the others are well under way in the yard. Through the courtesy of Robert C. Monteagle, chief draughtsman of the builders, we are able here to present several interesting photographs of the new tug *Gypsum King*, and accompanying data.

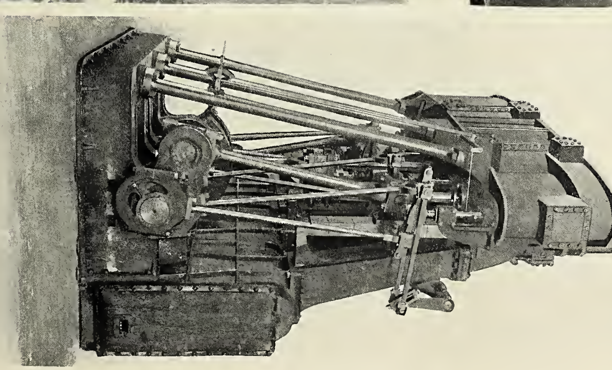
This vessel has the appearance in the water of a trading steamer rather than a tug. The hull is of mild steel, with double bottom extending between the water tanks at the ends, the hull being constructed according to Lloyd's rules. Her dimensions are: Length, stem to stern on deck, 165 ft. 0 in.; beam, moulded, 29 ft. 4 in.; depth from top of deck beam at side to top of keel at lowest place, 19 ft. She has five steel bulkheads, three of which are watertight. At the bottom of each bulkhead there is a composition sluice gate which can be operated from the main deck. This latter is of steel throughout, covered on the open spaces with heavy pine planking. The deck house is 90 ft. long and 16 ft. maximum width, built of steel. At the forward end of the house the steam steering engine is located, and aft of this on the starboard side the mate's room and on the port side a large ice-box. Next comes the mess room, the full width of the house, with doors opening into the galley next aft. A steel bulkhead separates the galley from the coal chute leading into the bunkers below. The next compartment aft is occupied by donkey boiler, crew's water closets, and uptakes from the main boilers. Aft of this the owner's sitting-room occupies the entire width of the house and communicates with two roomy staterooms and a bathroom and toilet. Another steel bulkhead cuts off the machinery space, and aft of this are the engineer's cabins on each side, with doors communicating with

STEEL TUG GYPSUM KING READY FOR SEA.



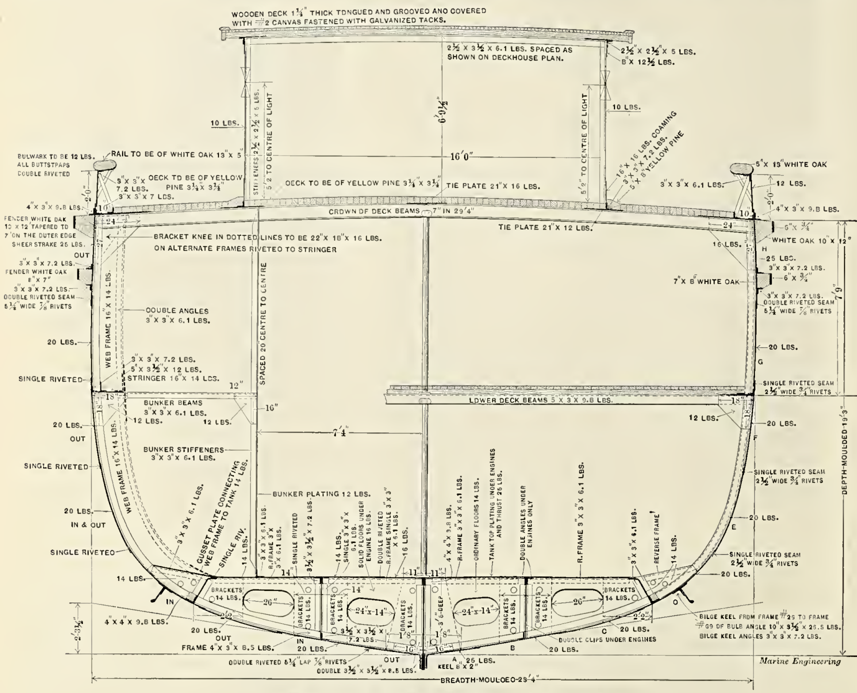






VIEWS OF HULL AND MACHINERY OF STEEL SEA-GOING TUG GYPSUM KING, BUILT FOR THE J. B. KING CO. FOR ATLANTIC COAST SERVICE—563 GROSS TONS.

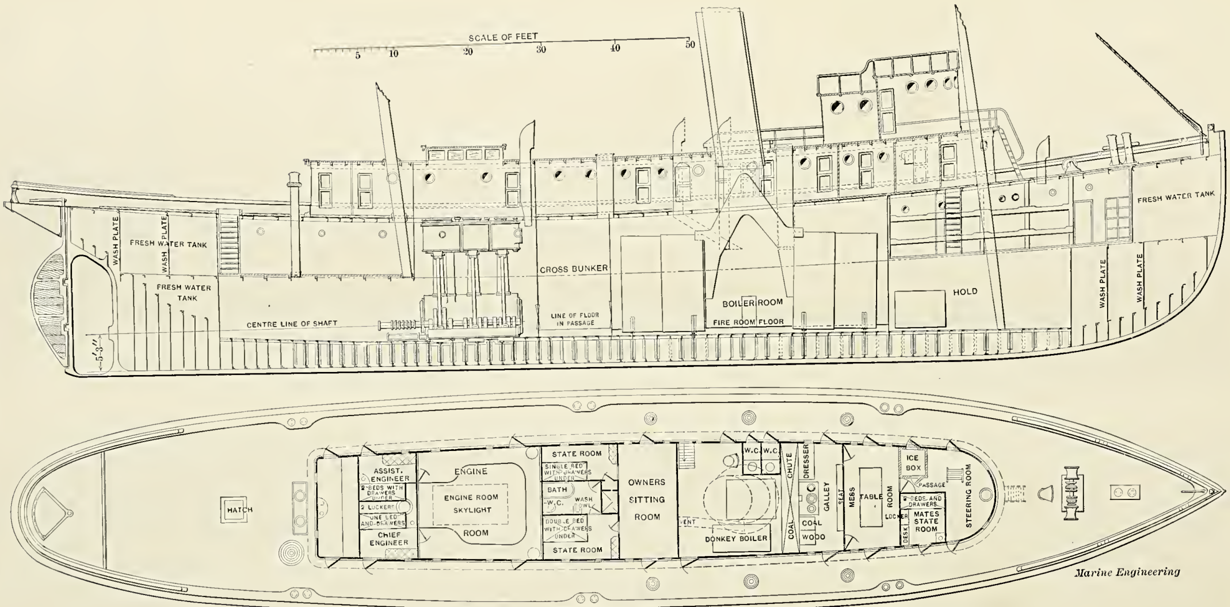
the upper grating in the engine room. The extreme after end of the house can be used for crew accommodation or for stores as need be. At the forward end of the steel deck house and on top is the pilot house and captain's room, also of steel plate, 19 ft. long. A ladder with brass rail leads to the top of the pilot house, which can be used for observation in fine weather. There are three coal bunkers, two at the sides and one cross-bunker between the engine room and boilers, with a total capacity of 300 tons. Coal is loaded through chutes in the house and also through the deck rings. Fresh water tanks are fitted at each end up to the height of the main deck, with a total capacity of 90 tons. Bilge keels are carried along the sides for a distance of about 72 ft. Communication with the lower deck, over the forehold where the crew is berthed, is ders 17 in., 27 in. and 45 in. dia. and 36 in. stroke. The front columns are steel forgings turned, and the back frames are securely bolted to the condenser. The H. P. valve is a piston valve, and the I. P. and L. P. slide valves. All the pumps are independent of the main engine. The engine crank shaft is of steel, built up and fitted with counterbalances. A direct operating steam reversing engine is fitted on the side of the high pressure cylinder and operated from the starting platform below. An independent direct acting air pump of the Worthington type is fitted, and there are also fire, feed, donkey, bilge, sanitary and wrecking pumps of the Worthington make. The circulating pump is of the centrifugal pattern, built by the Morris Machine Works. An independent feed water heater is fitted and piped to take the exhaust from the various auxiliaries.



CROSS SECTION OF STEEL SEA-GOING TUG GYPSUM KING.

had by a ladder opening into the steering engine room in the deck house, so that ventilation of these quarters is secured even in very rough weather. Aft of the machinery spaces the lower deck is carried as far as the after watertight bulkhead, to which access is obtained by a hatch in the steel deck above.

The *Gypsum King* has an extensive machinery equipment for a vessel of her class; in fact, she is in these respects a first-class sea-going job. The propelling engines are of the triple expansion type, with cylin- A hand pump and special ash ejector are also included in the equipment below. There are two main boilers of the Scotch type of 60,000 lbs. T. S. steel, designed for 175 lbs. working pressure. Each boiler is 13 ft. dia. and 11 ft. 2 in. long, and contains three corrugated furnaces 39 in. inside dia., set in separate combustion chambers. The stack is double, with an inside diameter of 5 ft. 4 in., and outside diameter of 6 ft. 6 in., the top being 55 ft. 6 in. above the bottom grates. An improved steam jet is fitted for urging the fires when



HULL PLANS OF STEEL TUG GYPSUM KING, BUILT AND ENGINED BY BURLEE DRY DOCK CO., PORT RICHMOND, STATEN ISLAND, N. Y.

needed. The donkey boiler is of the locomotive type, designed for 100 lbs. pressure and is large enough to run all the auxiliary machinery.

Electric lighting is used throughout. A vertical single Forbes engine, 5 in. by 5 in., is coupled direct to a dynamo, and at a speed of 650 revolutions furnishes current to one 8,000 C. P. searchlight and sixty 16 C. P. incandescent lights. There is also a storage battery having a capacity of 70 ampere hours. On the main deck forward there is a powerful Hyde steam windlass capstan. The *Gypsum King* is a strong, powerful vessel, designed for the special purpose of heavy towing rather than for running at speed independently. On her trial trip on Long Island Sound, however, she showed herself to be quite speedy for a vessel of this type, and her machinery worked with really remarkable smoothness. She developed over 1,100 horse power with less than the allowed pressure, and at no time had the engines to be slowed except when ordered from the pilot house. The excellent construction and performance of this vessel has called out favorable comment, especially as steel vessels of this type have hitherto been the product of yards at ports other than New York.

AMERICAN SCHOOLS OF MARINE ENGINEERING.

THE AMERICAN SCHOOL OF CORRESPONDENCE AT BOSTON, MASS.

Founded for the Education and Advancement of the American Mechanic — Courses confined to Steam, Electrical and Mechanical Engineering.

The American School of Correspondence was founded by two wealthy New York men who appreciated the need of better technical training among the American mechanics who could not attend a regular technical school. They saw the possibility of bringing a good course of technical instruction to the ambitious workman by correspondence, and gave liberally of their wealth to establish such a school. It was first organized in New York city; later, however, it was found advisable to transfer the School to Boston, as that city offers unusual advantages as a location for a technical school, being the home of Harvard University, with its great libraries and laboratories, Lawrence Scientific School, which gives the most advanced instruction in engineering; Massachusetts Institute of Technology; Tuft's College, and other well-known institutions.

In 1897 the School was chartered by the Commonwealth of Massachusetts as "an institution of learning in all branches." The work of the School, however, has been confined strictly to the three allied engineering branches—Steam, Electrical and Mechanical. In Steam Engineering the courses are limited to the three main divisions—Stationary, Locomotive and Marine. By thus specializing the directors believe that the School can give the students better and more personal instruction than would be possible were they to attempt a large number of courses. The School is purely an educational institution, founded to "educate and advance the American mechanic," the tuition being within the means of the wage-earner.

The officers and instructors of the School are all men well known in the educational field, and especially fitted for their work. The President, R. T. Miller, Jr., A.M., LL. B., brings to the management of the School wide experience along educational and business lines. The Secretary, George L. Fowler, A.B., M.E., is a consulting engineer and writer. He is a member of the American Society of Mechanical Engineers, and a frequent contributor to the engineering journals. At the head of the Advisory Board of the School is Dr. Robert Grimshaw, widely known as an engineer and machinist, and the author of numerous books relating to steam engineering and machine-shop work. Charles Thom, another member, is chief of the Quadruplex Department of the Western Union Telegraph Company, and is the author of "Telegraphic Connections"; Francis H. Boyer, M.E., is a constructing engineer and an authority on refrigeration, being a lecturer upon that subject at the Massachusetts Institute of Technology. Mr. Boyer is also a member of the American Society of Mechanical Engineers. Amherst W. Belcher, another member of the Board, is connected with the Cornell Steamboat Company.

The regular corps of instructors has been chosen from among the graduates of the leading technical schools, and are all experienced and enthusiastic teachers.

The work of the Instruction Department is carried on by means of bound instruction papers, of which there are from thirty to thirty-six in each course. Accompanying each instruction paper is an examination paper, which the student is required to answer and send to the School for correction and criticism. When this examination paper has been carefully examined and corrected by the instructor it is returned to the student with a certificate showing his proper grade. The corrections, suggestions and criticisms made by the instructor are very essential parts of the system, as they bring the student in close touch with his teacher.

The instruction papers of the School are prepared under the supervision of the most progressive engineers in the country, and in every case represent the best American practice. They are written in simple language and illustrated at every point where an illustration will make the explanation clearer. The inductive method is followed throughout the course, the object of the writers being to lead the student step by step from the simple fundamental principles to the more intricate engineering work.

As before stated, the work of the School is confined exclusively to Steam, Electrical and Mechanical Engineering. In Steam Engineering, special courses are offered in Stationary, Locomotive and Marine Engineering. The Stationary course is designed for engineers, firemen and all others desiring a better theoretical knowledge of Steam Engineering. The Locomotive course meets the needs of all connected with the great railway systems. The course in Marine Engineering, as the name implies, is intended for marine engineers, oilers, firemen and stokers, and others who desire a theoretical knowledge of the subject. This course is naturally one of the most comprehensive and advanced of the courses offered by the School, as the requirements in Marine Engineering are greater and the scope wider than in any allied branch of engineering.

The object of this course is to give students the necessary theoretical training, which, with their practical experience, will fit them for promotion to the highest positions in the service. It might be added that the technical instruction given is more complete than that required by any examiners for the highest grade of marine license.

The following outline of the Marine Engineering course will give an idea of the plan, arrangement and scope of the course: After enrolling, the student is first given four papers on Elementary Mathematics. These are specially prepared for them, and relate to materials and problems in actual practice, as boiler tubes, weights of various parts of machinery, coal burned, horse-power, etc., so that at the very outset the student is constantly acquiring important facts and data regarding engineering.

After Elementary Mathematics comes two papers on Mechanics. Although this subject is not easy to understand, these papers give so full explanations, so many illustrations and examples, that the student should meet with little difficulty. Following Mechanics is a paper on Heat. This subject is usually treated under the head of Mechanics, but as it is so important in the study of

Steam and Steam Engines, a separate pamphlet is devoted to it.

The sciences of Chemistry and Metallurgy then follow. Chemistry is treated briefly and without laboratory work, but the student learns how elements combine, the chemical reactions and facts relating to combustion. In Metallurgy only iron and steel are considered. The various ores, furnaces, materials and operations are fully described and illustrated. Cast iron and wrought iron are thoroughly discussed, with their characteristics and properties. The Bessemer and Open Hearth methods of making steel are illustrated and the properties of the different products considered.

After completing the foregoing work, which is general in its nature, the student begins his actual work on Marine Engineering. The Construction and Design of Boilers is first taken up. The various materials used in boiler work are described, with their uses, qualities and tests. The processes of cutting, planing, drilling, punching and shaping the plates, are discussed with the advantages and disadvantages of punching and drilling. Rivets and riveting follow, the shapes and specifications of rivets, hand and power riveting being the principal points explained. Other details of construction, such as the arrangement of plates and joints, stays, tubes and caulking, are described with numerous illustrations. The design of boilers is illustrated by giving all the steps in designing an ordinary multitubular boiler. The size of all the parts are calculated for capacity and strength; the chimney also is discussed, with a table of sizes. The various types of boilers are next described. Commencing with a brief history of early forms, the student becomes acquainted with horizontal and vertical, fire-tube and water-tube boilers. The locomotive and marine types of boilers are explained briefly at this point. The various fittings and details of boilers in general are discussed, such as furnaces, valves, cocks, gauges, fusible plugs and separators. The feed apparatus, including injectors, pumps and return traps, are described, as is also feed temperature and location of admission. Among the most interesting topics in this connection are corrosion and incrustation, boiler explosions, fuels and setting. The standard code for making boiler trials is given, also cautions and rules regarding the management.

The student in Marine Engineering thus becomes familiar with boilers in general. He then studies the Marine Boiler in particular. The forms, fittings and details are again taken up, but this time only in connection with the marine boiler. Such appliances as salinometers, evaporators and hydrokineters, being peculiar to marine boilers, are here explained. Draft, natural and forced, is given its due importance. Many of the rules of the U. S. Board of Supervising Inspectors of Steam Vessels are stated and explained, as are also those of the British Board of Trade. The management of marine boilers, including rules for building the fire, firing and banking the fire, and repairs, are discussed at length.

After completing the work on boilers, the study of Machine Design is commenced, thus giving variety to the work. Under this subject only the elements are taught, but the principles are of great value to the student. After explaining the properties of materials and the strains in machines, the various fastenings are taken up. Bolts, nuts, keys, cotters and gibs are illustrated by cuts, and the necessary mathematical formulas explained. Under this head the United States standard thread and proportions of bolt heads and nuts, with the common forms of locking devices, are illustrated. Bearings, pedestals, brackets and couplings, with the empirical formulas for the various proportions, are given. Instruction on tooth, belt and rope gearing is full and thorough; the calculation of velocity, ratio and horse-power transmitted being of special importance. Ratchets and pipe joints also receive proper attention.

After having thoroughly mastered the methods of boiler construction and machine design, the student takes up the study of the steam engine proper. As in studying boilers, he first learns the general principles of engines.

Commencing with the inventions of Watt, Savery and Stephenson, the principle of the steam engine is explained as it was developed. In this connection, the laws of the expansion of steam are discussed and also the table of the properties of saturated steam. The parts of the simplest forms of steam engines are then explained and illustrated. Engines are divided into classes, as high and low speed, condensing and non-condensing, horizontal and vertical, etc., and each class is described with its special advantages under various conditions.

An entire paper is devoted to the study of the Indicator and Indicator Diagrams. This subject is of great importance, especially to the man who has had the practical training of the engine-room, but whose theoretical knowledge is wanting. Three kinds of indicator—the Crosby, Thompson and Tabor—are thoroughly explained, and their peculiarities and advantages pointed out. The theoretical indicator card is discussed with the actual, the differences being explained and the causes of losses pointed out. The methods of finding the area are explained with a cut and description of a planimeter. The cards for compound and triple expansion engines are next taken up; the horse-power computed and the cards combined for the expansion curve. The calcula-

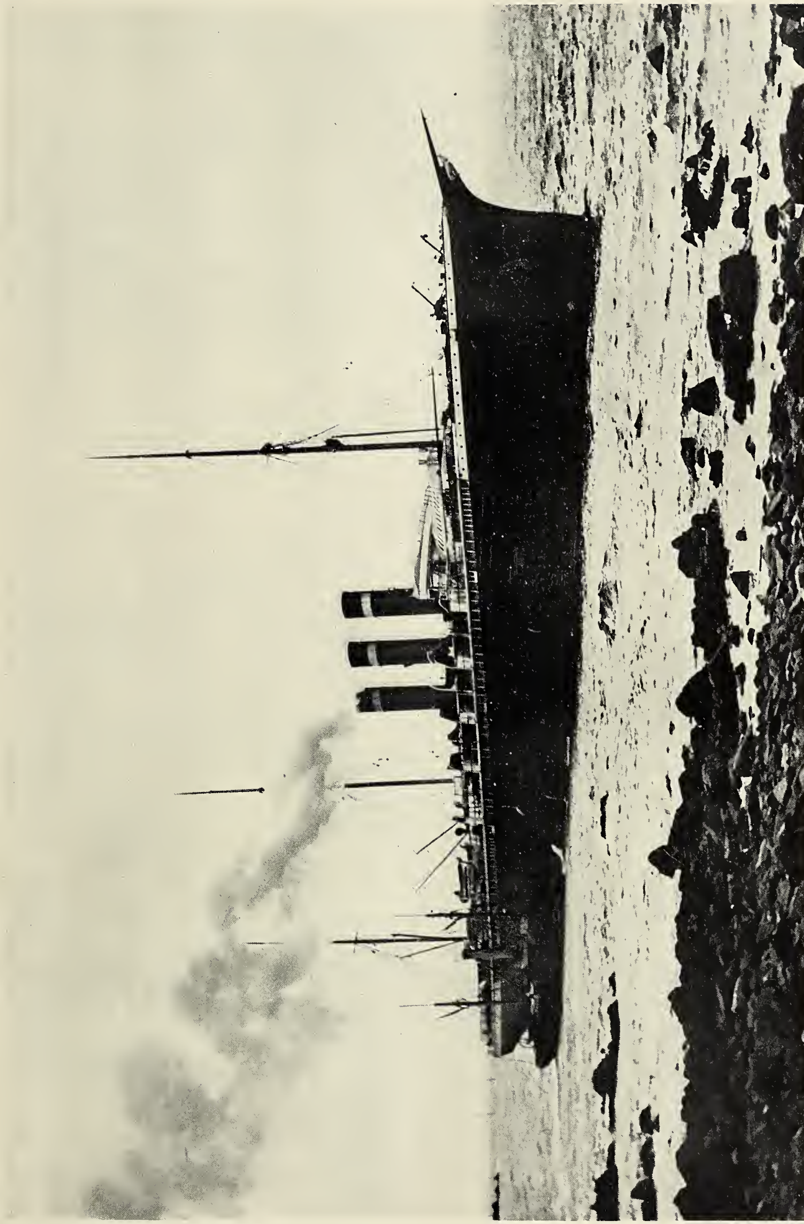
(*Continued on page 124.*)

Recent Mishap to the Liner Paris.

In our issue of last month we published an account of the mishap to the former American liner *Paris*, which went ashore on the Manacle Rocks, off Lowland's Point, on the coast of Cornwall. On the two following pages we now publish reproductions of photographs taken on the spot for MARINE ENGINEERING, but which were delayed in transit, and so did not arrive in time for reproduction in our last issue. The position of the *Paris*, both as regards the shore line and the immediately surrounding rocks, can be clearly seen from an inspection of the pictures; and a view which is of special interest is that showing the position of the *Paris* with regard to the wreck of the *Mohegan*, the masts of which can be seen sticking up above the water, and in the foreground the bell-buoy which warns ships away from this dangerous spot. Since the publication of the article in our last issue the vessel is reported as having proceeded under her own steam to Milford Haven, and there gone into dock. Her damages, as we before stated, do not appear to have been as considerable as would be expected by her position so far inshore.

TUGS MAKING AN EFFORT TO PULL OFF THE S.S. PARIS AT HIGH WATER—MAINLAND IN THE FOREGROUND.

S.S. PARIS ASHORE. WRECK OF S.S. MOHEGAN. MANACLES BELL BUOY.



VIEW OF THE TWIN SCREW TRANSATLANTIC STEAMSHIP PARIS ON THE MANACLE ROCKS, SOUTH COAST OF ENGLAND, AT LOW WATER.
Photograph taken for Marine Engineering by W. M. Harrison, Falmouth, England.

tion of the horse-power of engines is simplified by means of a table of engine constants. The faults found in cards, together with the remedies, are pointed out, sample cards being shown for illustration.

The various valve gears, with the Zeuner diagram, are next explained, as are also the various valve gears, among them the Corliss, Meyer and Joy gears. The forms of reversing gear, both for locomitive and marine work, are described.

In the fourth paper on the Steam Engine the various details are taken up. The governor, fly-wheel and lubrication is treated as fully as the space will allow. When the student has reached this point in the course he is in a position to learn something of the theory of the steam engine. Therefore, cylinder condensation, re-evaporation, compounding, jacketing, superheating and lubrication are discussed, showing the causes for loss in efficiency and also the methods taken for prevention.

The Marine Engine is studied last, as was the marine boiler; the requisites, peculiarities and sizes are treated, together with a brief discussion upon the Screw Propeller and the Resistance of Ships. The advantage of the various types under given conditions are stated. A few hints regarding the care, repairing and testing of engines and pumps conclude this subject.

At the present time the marine engineer should know something of Electricity. The course, therefore, includes some elementary work upon the principles of dynamo electric machinery. The work on electric lighting is optional with the student, but on account of its importance it is strongly recommended. Advanced Mathematics are also made optional in the course on Marine Engineering, because the time of many students is limited, and they desire to devote what little they have strictly to engineering.

The work in Mechanical Drawing, which is included in the course, may be taken up at any time. The student is taught the use of drawing instruments, the fundamental principles of drawing, and learns to make working drawings of simple parts of machinery. After completing this he is given a rough sketch of the details of the steam engine, which he is required to draw to scale, and finally to make an assembled drawing.

After having completed the course in Marine Engineering and satisfactorily passed the final examination, the student is awarded a diploma certifying this fact. A diploma from the school is one of the strongest recommendations in securing a better position or an advance in salary.

A distinctive feature of this school is its Special Inquiry Department, conducted by a corps of consulting engineers, who offer to engineers, shop proprietors, superintendents, foremen, as well as to all members of the school the privilege of submitting to them any question in engineering that may trouble them. Such questions are referred to the man most capable of treating them, and the solution is promptly forwarded to the inquirer. When necessary, diagrams are furnished and complete data given.

A careful study of the modern correspondence system will demonstrate how important a factor it is in the education of the wage-earning classes. While it is not claimed that correspondence study is as valuable as regular student life at a university or scientific school, still it places within the grasp of those unable to attend such an institution the substance of a technical education, and lends valuable aid in their effort towards self-culture.

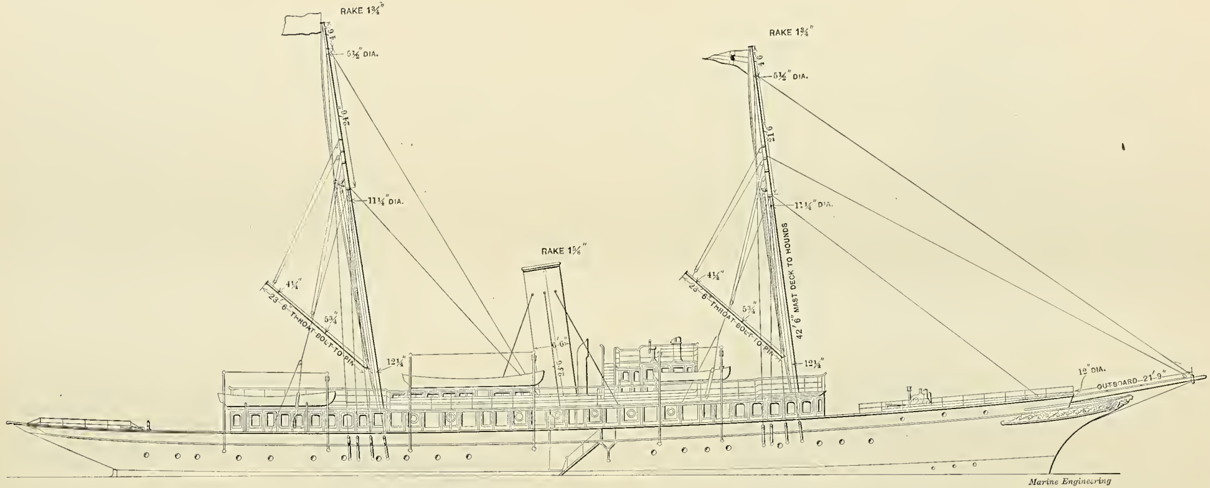
STEEL STEAM YACHT FOR ISAAC STERN BUILT IN U. S. FROM WATSON DESIGN.

A contract has been made between Isaac Stern, of New York, and the Bath Iron Works for the construction of a steel steam yacht, which will probably be named the *Virginia*. This new vessel is being built from a model and sketch plan furnished by Geo. L. Watson & Co., of Glasgow, Scotland; but the builders have prepared the specifications and are working up the design themselves under the supervision of the owner's representative, Mr. Tams, of the firm of Tams & Lemoine, New York.

The new yacht will be a strong, seaworthy, comfortable and handsome vessel. In appearance she will resemble somewhat the steam yacht *Andria*, which was constructed by the Ailsa Shipbuilding Co., of Troon, Scotland, two years ago for John E. Brooks, of New York city, from Watson designs. The *Virginia* will be 165 ft. long on the water line, with a 20 ft. overhang aft and a 15 ft. overhang forward, making the over all length of hull 200 ft. The molded beam is 25 ft. 9 in.; molded depth at side, 15 ft. 4 in.; molded depth at center, 16 ft. 1 in. Height between decks, 7 ft. 6 in., and draught aft, in cruising trim, 12 ft. The scantlings of the yacht are all equal or in excess of the requirements of the British Lloyds and the American Shipmasters' Association, and she will receive the highest classification in the latter society. The vessel has a bar keel and very little deadrise; the midship section being rather full. Notwithstanding this fact the displacement is fairly well proportioned fore and aft, and she carries her bilge well out towards the ends, the bow section being of a most pronounced U form. The full midship section allows a large Scotch boiler of sufficient power to drive the vessel at her designed speed to be placed below the main deck, and by using one large boiler instead of two smaller ones the length of the machinery space is greatly reduced.

The *Virginia* will have a large steel deckhouse handsomely paneled in mahogany 105 ft. long and 14 ft. wide. Between the fore and main rigging the top of this house will be carried out to the side of the vessel, forming a most desirable shade deck. There is a break in the main deck at the collision bulkhead, which is about 30 ft. from the bow, and a forecastle deck will be fitted up to this point at the height of the main rail. Five steel watertight bulkheads will be worked up to the level of the main deck, two watertight bulkheads will stop at the lower deck, and two non-watertight bulkheads will also extend up to the main deck. The main deck is plated with steel for half the length amidships, and steel carefully concealed by the finished woodwork will be worked wherever strength is required. Bilge keels 13 in. deep and 70 ft. long formed of steel plates connected to the hull by a T bar will be worked on each side of the vessel.

Much attention is being given to the vessel in all her



PROFILE OF SINGLE SCREW STEAM YACHT VIRGINIA FOR ISAAC STERN OF NEW YORK—WATSON DESIGN, AMERICAN BUILD.

departments. The cabin arrangement will be ample and luxurious, and the accommodation will comprise every requisite to insure comfort and convenience. All the decorations and fittings will be elegant, efficient and tasteful, and up to the builders' standard for first-class yacht work. The owner's accommodation occupies a space 42 ft. long just forward of the machinery space. Here are located six large staterooms, excluding the maid's room, three toilet rooms and a box room. The staterooms will be finished in white china gloss, with mahogany trimmings. Each room will contain a bed, lounge or transom seat, bureau, chiffonier, wardrobe and the usual smaller portable furniture. The toilet rooms will be paneled and finished in the same style as the staterooms, but a tile dado will extend about 4 ft. above the floor, and the floors will be covered with rubber tiling. In each toilet room a 5 ft. bathtub, w. c. and lavatory will be placed. The plumbing will all be open and nickel plated. Aft of the machinery space there will be three staterooms and a toilet room to be fitted up for the owner's guests. They are known as the "bachelor's quarters," and the finish of these rooms will be in every way equal to that of the owner's forward rooms. Aft of the bachelor's quarters are five staterooms, a w. c., a wardroom and a messroom for the officers. Forward of the collision bulkhead are the crew's quarters. Eighteen berths, a bathroom, washroom and w. c. will be fitted here, also clothes lockers, seats, etc. In the forward part of the deck house is the dining saloon, finished in mahogany,

with sideboard, tables, revolving steamship chairs and all the usual furnishings. Adjoining the dining room is the pantry and a vestibule, from which a stairway leads to the shade deck above. The galley is located between the fire room hatch and the pantry. The main saloon is located abaft the engine hatch, and a passage way inside the deck house connects this saloon with the dining room forward. The saloon will be finished in white gloss with very dark mahogany furnishings. An open fireplace, piano, upholstered transom seats, etc., will make the room very comfortable and homelike. Aft of the main saloon is a deck w. c., a stairway leading below to the bachelor's quarters, a stairway leading below to the officers' rooms and a smoking-room. The latter room will be finished in light oak, natural finish. A small house on the shade deck forward contains the chart room and observation house, and the top of this house extends out to the sides of the vessel forming the navigating bridge. The *Virginia* will be fitted with six boats, viz.: a 26 ft. steam launch, a 25 ft. gig, a 22 ft. lifeboat, a 21 ft. cutter, a 16 ft. and a 14 ft. dinghy. A refrigerating machine will probably be fitted, also a large cold storage chamber. The vessel will have a Williamson steam steerer and a Hyde steam brake windless, with engine under the deck. There will be a modern electric plant on board, with searchlight and a storage battery. The ventilation, steam heat, water service and plumbing will be excellent and complete in all respects.

The spars of the *Virginia* will be lofty, with a pleasing rake and graceful taper. The foremast is 60 ft. high above deck and the mainmast 75 ft. The bowsprit projects 24 ft. outboard and the sliding French gaffs are each 23 ft. long.

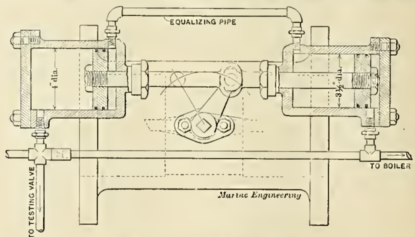
The propelling machinery of the yacht will consist of a vertical triple expansion engine and a steel single ended Scotch boiler. The engine will develop 1,100 I.H.P. with forced draft, and about 650 I.H.P. with natural draft. The cylinders will be 16 in., 26 in. and 41 in. dia., with a stroke of 27 in. The boiler will measure 14 ft. mean diameter and 11 ft. 3 in. long. It will have three Morison suspension furnaces 43 in. dia., with a separate combustion chamber to each furnace. The working pressure will be 180 lbs. The total grate surface provided is 64 sq. ft., and the total heating surface about 2,000 sq. ft. A donkey boiler 4 ft. 6 in. diameter and 10 ft. high, built for a working pressure of 90 lbs., will be fitted.

The designed speed of the *Virginia* is about twelve knots per hour, natural draft, and about fourteen knots per hour, forced draft. It may be of interest to here state that the steam yacht *Andria*, which is fitted with machinery of the same size as the *Virginia*—indeed built from the same engine specification—attained a speed of 14.66 knots per hour, forced draft, on her official speed test. The engine averaged 155 revolutions per min., the steam pressure was 179 lbs., and the I. H. P. about 1,200. The *Andria* is a smaller boat than the *Virginia*, being 4 ft. shorter and a little narrower, but the machinery in the two vessels will be almost identical. The *Virginia* will carry 110 tons of coal and 20 tons of fresh water. She will undoubtedly prove a fast, staunch and comfortable cruiser, yachty and trim in appearance, and a credit to her builders and designers.

IMPROVED APPARATUS.

McLaughlin Safety Stop Valve.

Fatal accidents on board steamships caused by the bursting of steam pipes are frequently reported, and since the very great modern increase in the number of fast-running engines with high pressure steam, in small speedy vessels, a corresponding increase has taken place in the number of fatal accidents caused by the breakdown of engines and the immediate filling up of the engine room with steam direct from the boilers. Numerous safety devices have been exploited for the purpose of checking the flow of steam in pipes in case of mishap. A form of safety stop recently put on the market is that shown in our engraving of the McLaughlin Safety Stop Valve. This is one of the forms in which the valve is applied, here taking the shape of a butterfly valve which is inserted in the steam main. By reference to the drawing it will be seen that on the stem of the butterfly valve an arm is fitted which is connected by a pin to the piston rod. This rod carries a piston on each end, the pistons

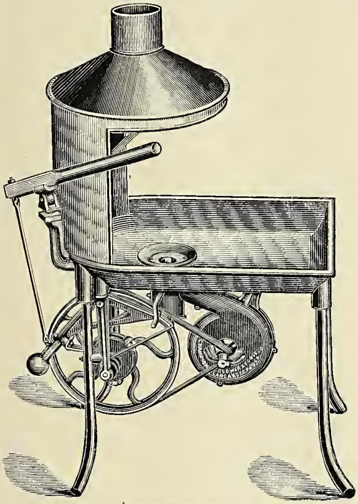


SAFETY STOP ON STEAM MAIN.

being of different diameters. The small cylinder is connected at its back end by a pipe direct to the boiler, while the larger cylinder is similarly connected with, however, an extension of the pipe leading away to various stations for the operation of this valve. A branch also leads from the release pipe to a convenient position where a valve is fitted, so that the engineer may from time to time operate the safety stop by opening the release valve and watching the movement of the piston rod and the arm of the butterfly valve. The operating stations are placed at convenient points where a break might be likely to occur in the pipe system. At each station there is a "safety box," in which there is fitted a valve containing a short section of common water gauge glass, against which a trigger rests. This trigger passes through a small stuffing box in the cover of the safety box, and has a small plate or knob fitted on the end, which can be struck by the hand or foot, according to the location of the box. A by pass is fitted to go around the safety box, which can be used as an alternative method when there is no necessity to shut the safety valve instantly. The manufacturers believe that the breakable glass tube offers a primitively simple and sure means of operation by unskilled persons, who, in the excitement attending a mishap, might forget which way to turn a valve to open or close it. This valve is manufactured by the Barr Pumping Engine Co., Germantown Junction, Philadelphia, Pa. Another form of this safety device is used in connection with the main boiler stop valves.

Portable Lever Forge.

The forge shown in the illustration is specially designed and constructed for the use of machinists and plumbers and for repair work. It is fitted with lever motion of an improved form, which has been applied to many thousand forges with unvarying success. The style shown here is half-hood, but there are many other

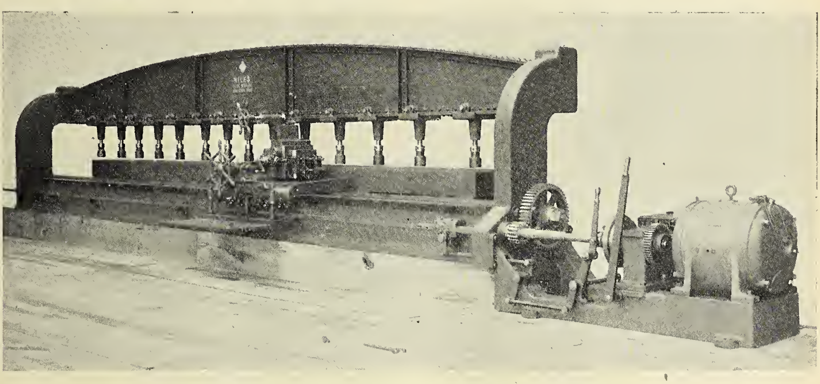


CHAMPION PORTABLE FORGE.

styles suited to special needs. The size of hearth is 23 in. by 35 in. and the fan is 12 in. dia. The height of the forge is 30 in. and the weight 130 lbs. The forge is fitted with the ball tuyere iron and with ball-joint brass oscillating bearings. It is guaranteed to produce a welding heat on 3 in. iron in five minutes. The forge is manufactured by the Champion Blower and Forge Co., Lancaster, Pa.

Heavy Plate Planing Machine.

Our engraving shows a heavy plate planing machine recently constructed by the Niles Tool Works, Hamilton, Ohio, to plane plates 2 in. thick and 25 ft. long with one setting, or any lengths by additional settings. The bed is extra heavy, to which brackets are attached carrying the work table. The work table is provided with T-slots and stop holes. The work is held by trolley jack-screws, which are hung on the flange of a heavy box girder amply stiff to take the thrust of the screws. The housings are secured to the bed by bolts and dowels. The driving screw is of large section, 2 in. pitch and supported for its entire length on the bed. It is provided with ball-bearings at each end for taking up end thrust. The carriage carries two tool slides, one with horizontal movement and the other with both horizontal and vertical motion. One of the tool aprons is constructed as to take a cut in either direction. The reversing is done automatically and very quickly. Provision is made for starting and stopping by hand. The driving mechanism is held on a gear frame rigidly attached to the bed and bolted to the foundation. This machine is driven by an electric direct motor coupled to the driving mechanism. A special automatic controller is used for starting, stopping and reversing the motor, and to protect it under all conditions. The motions of the carriage are governed wholly by the direction of the rotation of the motor, and the power required by the motor is, at all times, exactly proportional to the work done by the machine. The operator controls machine either at the carriage or by lever at the motor. The performance of the motor is entirely independent of the quickness or slowness with which the lever is thrown. On this machine provision was made for pulleys also, and the motor is connected to the driving mechanism by a friction clutch, so that the machine can be driven either electrically or by belt as desired.



HEAVY PLATE PLANING MACHINE, BUILT BY NILES TOOL WORKS CO

Captured Spanish War Vessels.—Work is progressing rapidly on the reconstruction of the captured Spanish war vessels, *Don Juan de Austria, Isla de Cuba* and *Isla de Luzon,* at Hong Kong. These vessels were damaged chiefly by fire, and after they were raised at Manila they were found to be available for service.

MARINE ENGINEERING

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WITHIN a few days of the publication of this issue, if all goes well, the magnificent new steamship *Oceanic*, of the White Star Line, will arrive in New York harbor. Probably no merchant vessel since the *Great Eastern* has attracted so much attention among marine men and the general public, and this is quite natural, as each vessel represents a more than ordinary advance in dimensions over prevailing practice, and each is the biggest of its day. Indeed, in making comparisons between the *Oceanic* and preceding vessels, the *Great Eastern* has invariably been selected as the vessel of all others which can be best contrasted with the new leviathan. For this reason we have placed before our readers in this issue a memorandum of the chief characteristics of each vessel, accompanied by original and authentic photographs. Putting the vessels side by side, as it were, without any consideration of the magnitude of the problem confronting the respective designers and constructors of the old and new, there are several points which are of interest. At the start it may be said that, so far as published data goes, there is more exact information available concerning the *Oceanic* than the *Great Eastern*. Various authors differ in the particulars of the *Great Eastern* that they give, the cause for this no doubt being the different conditions under which observations were made. The vessel never entered the service for which she was built, and in her active life was engaged in widely differing work. Even while in the transatlantic trade she was not taxed to her full capacity. By comparing the general dimensions of each it will be observed that while the *Oceanic* (704 ft.) is 12 feet longer over all than the *Great Eastern*, she is but 5 feet longer between perpendiculars. The *Great Eastern* was, however, 15 feet wider and 8 ft. 6 in. deeper than is the *Oceanic*. The ratios of length to beam of the vessels are 8.19 for the *Great Eastern* and 10.07 for the *Oceanic*. These dimensions, however, do not entirely regulate the important item of displacement, and it is here that the *Oceanic* gains considerably. Her owners announce that at the load draught, with all cargo, stores and coal aboard ready for sea, she will draw 32 ft. 6 in., and will displace 28,500 tons. This draught is certainly very much greater than what may be called the normal draught of the *Great Eastern*, which on her first transatlantic voyage drew 22 ft. forward and 26 ft. aft. The light draught of the *Great Eastern* is given as about 16 ft., and load draught for her designed service 30 ft., with a maximum displacement of 30,000 tons. Under her actual conditions of service it is probable that the load draught of the *Great Eastern* was less than 26 ft., and her displacement 27,000 tons. There is a considerable difference between the weights of hull of the vessels, the launching weight of the *Oceanic* being somewhere between 10,000 and 11,000 tons, while, from the most authentic accounts at the time, the launching weight of the *Great Eastern* was somewhere between 8,000 and 9,000 tons. The hull of the *Oceanic* is, of course, of tremendous strength, built to carry undisturbed the immensely greater horse power and to make steady progress at speed on the Atlantic even in the roughest weather. Her skin plates are on an average about 1 1-4 in. thick, while those of the *Great Eastern* were only 3-4 in. thick; and again, the systems of framing of the vessels differed very materially. Taken altogether, then, under the actual conditions of service, the *Oceanic* is undoubtedly the "larger" ship, though there is no necessity to magnify her dimensions, and at the same time to minimize those of the *Great Eastern*, a tendency observable in certain quarters. Success brings success, and while the enterprise of the owners and the splendid achievements of the builders of the *Oceanic* are entitled to full and unconditional credit, the similar qualities which those gone before have shown are, comparatively, not overshadowed.

Without the aid of modern material, modern methods and tools, and above all the intervening forty years of experience and scientific advancement, the *Oceanic* could not be the success that she has so far shown herself. The *Oceanic* is timely, the *Great Eastern* was premature. Her designers and builders were far in advance of their times (considering the then possible economies of operation and prevailing conditions of trade), and so long as the science and art of marine construction exist so long will their names remain near the top. Now and again some unconscious (possibly) imitator comes along and claims credit for what long ago these men put in practice. For example, the recent claim by one of the German lines that a projected ship would be the first afloat to have a double skin, while this very idea was one of the merits of the really *Great Eastern*. To equal the achievements of the *Great Eastern's* builders to-day would mean the construction of a vessel of about 1,200 ft. in length, and capable of a sea speed of not less than 30 knots.

ONE development along the line of advanced education which has taken an established place in American educational work is the correspondence school. It may be considered supplemental to the great educational activity of the past quarter of a century in America, which has found expression in the broadening and extension of university work, largely through the liberality of public spirited men. Increased facilities have brought an increasing demand for instruction in the higher branches of knowledge, and especially those of a professional character, which the public or private school must of necessity leave untouched. To secure special university training by personal attendance is usually impossible for the man engaged in practical work, with, often, domestic responsibilities. It is here that the correspondence system becomes indispensable. The facilities for a technical education are carried to the door of the student, no matter where he may reside, and while this has disadvantages, even under these special circumstances, it has at least one marked advantage over instruction in the class room. There the progress of the individual student is governed largely by that of his fellows, while with the correspondence method he receives individual instruction suited to his special needs, so that if diligent his progress is surprisingly rapid. To be sure, the student, unless he be very methodical, is apt to gain knowledge intermittently as he is rid of the call of the class room for regular attendance at specified hours. Here again is advantage and disadvantage. Should he be unable to maintain "regular attendance," as it were, due to unforeseen causes, say overtime or extra work ashore or afloat, he need not resort to bluffing tactics in recitations to keep up with his class, but can make each step deliberately, using such times for study as best suit his occupation. As his work is written, there is small chance for misleading his instructor as to his abilities or information. It should never be forgotten, though, that faithful work is the only sure means of acquiring knowledge, whether by correspondence or by word of mouth. There is no easy way, or rather no absorbent method, of gaining knowledge, but the student must masticate and digest the facts and theories whether he gets them by mail or in the class room. Among practical men there is, unfortunately, too often shown a spirit of intolerance of theoretical discussion, which arises usually from a consciousness of considerable practical knowledge or from mental laziness. The one believes he knows more of the "real" tangible engineering work than can be "learned out of a book," and the other sees, in even a simple formula, an added and unnecessary burden of work. Such men, at some time or another, must stand aside and let the procession of knowledge pass on, and take comfort in their non-success and the success of others by growling about favoritism or a pull. We have been at some pains to present to our readers in several recent issues facts regarding the facilities for technical education in America in our special branch of engineering work, and this month we bring the series to a close. There are to-day, in this country, as good opportunities for securing a scientific training in naval architecture and marine engineering as exist in any country in the world, and better than in any country outside of Great Britain, and we know whereof we write. That the work of the various educational institutions will tell in time in the progress and standing of American shipbuilding and engineering there can be no denial.

THE value of wireless telegraphy at sea was demonstrated under working conditions during the recent British naval manœuvres, reported elsewhere in these pages. At a critical moment a cruiser of one fleet sent a message a distance of about 80 miles back to the flagship, and the fleet was thus able, far in advance of its arrival at a given point, to anticipate the needs of the moment.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—RIVETED JOINTS.

BY DR. WILLIAM FREDERICK DURAND.

The various joints in a boiler are usually of the riveted form. The use of welded joints in various parts of boiler construction is increasing somewhat as greater skill is acquired in making them, but in ordinary practice the joints are riveted, and of various types, as follows:

Riveted joints are divided into *lap* joints and *butt* joints, according as the plates lap over each other (see Figs. 5-8), or butt together at the edges, and are covered by one or two butt straps (see Figs. 9-13). They are also divided according to the number of rows of rivets into *single, double* or *triple* riveted joints (see Figs. 5-7).

The rivets are usually *staggered* in arrangement, as shown in Figs. 6-13. Sometimes, though rarely, the *chain* arrangement, as shown in Fig. 1, is used. While chain riveting is as strong, or perhaps even slightly stronger, than staggered riveting, the latter gives a better disposition of rivets for making a steam or water-tight joint, and this fact leads to its more frequent use in boiler construction. In butt joints the arrangement of rivets is duplicated on each side of the joint, and the style of riveting is named according to the arrangement on one side. Thus, Fig. 9 shows a double-riveted and Fig. 10 a triple-riveted butt joint.

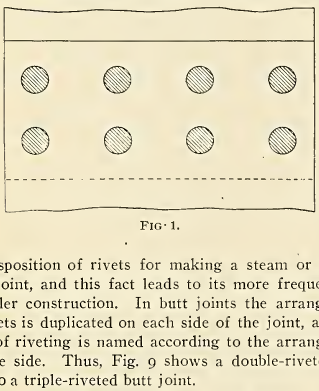

FIG. 1.

A riveted joint may fail: (1) In the plate by tearing out or across from hole to hole, see Figs. 2-3; (2) in the rivet by shearing; (3) in the plate or rivet by a crushing of the material.

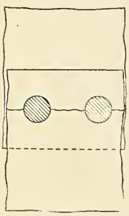

FIG. 2.

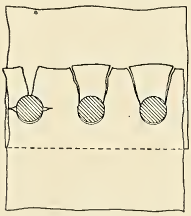

FIG. 3.

The failure of a joint by the tearing out of the plate in front of the rivet, as in Fig. 3, is safely guarded against by placing the row of rivets at a proper distance from the edge of the plate. This, by experience, is found to be about one diameter in the clear, or one and one-half diameters from edge of plate to center line of rivets. In lap joints and butt joints with one cover, as in Fig. 4, the rivets resist shearing at one section only. In butt-joints with double covers, as in Figs. 9-12, the rivets resist shearing at two sections. The total shearing strength of a rivet in double shear is usually taken as somewhat less than twice the strength in single shear. The British Board of Trade rules give 1 3-4 as the ratio to be used.

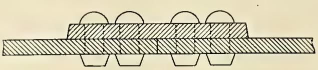

FIG. 4.

With usual proportions the last mode of failure mentioned above is the least likely to occur, so that so long as the proper limits are not exceeded the resistance to crushing needs no especial examination. These limits will be given in detail at a later point.

The strength of a riveted joint is, of course, determined by whichever is the weaker of the two, the plate or the rivets. In a properly designed joint the strength of the plate and that of the rivets should be equal, so that there will be no more likelihood of failure in one way than the other. It may be remarked, however, that since corrosion usually affects the plate only, it is often considered good practice to give to the plate a slight excess of strength, so that even after some wasting by corrosion the joint may still be in fair proportion as to the relative strength of plate and rivets. No exact directions can be given for this increase, as it is simply a matter of judgment.

The investigation of the strength of riveted joints by any simple theory is necessarily quite imperfect, because we do not know in just what way the stress is distributed through the remaining part of the plate, nor through the section of the rivet, nor what allowance to make for the frictional grip of the joint. The proportions given by the following equations, however, are those which will give practically equal strength of plate and rivets, using the British Board of Trade rules. These rules represent standard and reliable practice, based on wide experience, and are substantially adopted by the United States inspection authorities. In thus considering a joint we take simply an element such as that between AB and CD in the following diagrams. It is clear in each case that the whole joint may be considered as made up of a series of such elements:

Let p denote the *pitch* of the rivets: that is, the distance from center to center. Where the rivets in one row are pitched twice as far apart as in another (see joints D, H, etc.), p denotes the larger of the two values.

" d denote the diameter of rivet.*

" $n = p \div d$ = number of rivet diameters in the pitch.

* NOTE.—Strictly speaking the diameter of the rivet *hole* should be used, as it is about $\frac{1}{16}$ inch larger than the rivet before heading up. In the Board of Trade Rules, however, the diameter of *rivet* is used. The difference in proportion of joint is quite small, and probably not of practical importance.

Let t = thickness of plate.
" $a = t \div d$.
" T = tensile strength of plate per square inch of section.
" S = shearing strength of rivet per square inch of section.

The ratio of S to T is taken as 23 : 28 or $S = .821\ T$.

The *efficiency* of the joint is the ratio between the strength of the joint and the original strength of the plate. It will be seen by the formulæ given later that the efficiency of a joint is inereased as d and p are made larger. There is, however, a practical limit to the increase in d, due to the difficulty of heading up very large rivets, and a limit to the increase in p, due to the necessity of guarding against leakage. If the general proportions between d and t, as indicated later in connection with the various joints, are observed, the result will be a pitch within safe limits, and a joint agreeing well with the best practice.

The largest permissible values of the pitch, according to the Board of Trade rules, are given by the following formula:

$$p = C\,t + 1\tfrac{5}{8}$$

where C is drawn from the following table:

Form of Joint as Shown Below.	C	Form of Joint as Shown Below.	C
A................	1.31	F................	4.63
B................	2.62	G................	5.52
C................	3.47	H................	6.00
D................	4.14	I................	6.00
E................	3.50		

In no case should the pitch exceed 10 inches.

We will now proceed with the equations and proportions for various forms of riveted joints.

Joint A *Lap Joint* *Single Riveted*

$h = 1\tfrac{1}{2}\,d$

$B = 3\,d$

The element is $A\ B\ D\ C$, containing one rivet. We have in this case:

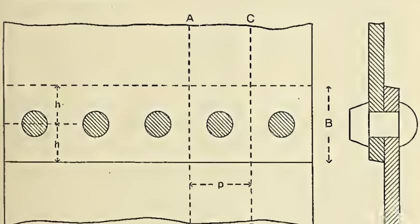

FIG. 5.

Strength of Plate $= t\,(p - d)\,T$

Strength of Rivets $= \frac{1}{4}\pi d^2 S$

For equal strength of plate and rivet,

$$\frac{p}{d} \text{ or } n = 1 + .645\,\frac{d}{t}$$

$$efficiency = \frac{n - 1}{n} = \frac{.645}{a + .645}$$

The ratio $d \div t$ may vary from 1.5 to 2.5, the lower values being more commonly employed with very thick plates on account of the difficulty of heading up excessively large rivets, and the necessity of a moderate pitch to insure against leakage. In order, furthermore, to guard against danger of rupture by crushing, the upper limit, 2.5, should not be exceeded.

The foregoing operations may be expressed also by the following:

Rule. (1) Select a diameter of rivet according to the thickness of the plate and the directions given.

(2) Multiply this diameter by .645 and divide by the thickness of plate.

(3) Add 1 to the result obtained in (2).

(4) Multiply the diameter of rivet by the result obtained in (3), and the result will be the pitch suited to the diameter chosen.

(5) Select the nearest working dimension, going usually above in order to give slight excess of strength to the plate.

(6) To find strength of plate in the joint, subtract the diameter of rivet from the pitch, multiply by the thickness and by the tensile strength per square inch of section.

(7) To find strength of rivet, find area of section, multiply by the same strength per square inch as in (6), and then by .821.

(8) To find original strength of plate multiply pitch by thickness of plate, and by the tensile strength per square inch, as in (6).

(9) To find the efficiency, divide the lower of the two results found in (6) and (7) by that found in (8).

Example. To lay out a single riveted lap joint for 1-2 inch plates, using 7-8 inch rivets.

$$\text{Then } \tfrac{7}{8} \times .645 \div \tfrac{1}{2} = \frac{7 \times .645 \times 2}{8} = 1.13$$

And $1.13 + 1.00 = 2.13$.

And $2.13 \times \frac{7}{8} = 1.86$ = pitch.

Take the nearest eighth above and we have pitch = 1 7-8 inch.

Then taking strength of plate at 60,000 lbs. per square inch, we have:

Strength of Plate in Joint $= (1\frac{7}{8} - \frac{7}{8}) \times \frac{1}{2} \times 6{,}000 =$ 30,000.

Area of $\frac{7}{8}$ inch rivet = .60 sq. in.

Strength of rivet $= .60 \times 60{,}000 \times .821 = 29{,}550$.

Original strength of plate $= 1\frac{7}{8} \times \frac{1}{2} \times 60{,}000 = 56{,}250$.

Efficiency $= 29{,}550 \div 56{,}250 = .525$.

Similarly, if we should take 15-16 inch rivets, we should find for equal strength in plate and rivet a pitch of 2.07 inches. If we take a pitch of 2 1-8 inches we shall find an efficiency of .533. If we take the 2.07 exact the efficiency will be .548.

Joint B. *Lap Joint.* *Double Riveted.*

$h = 1\tfrac{1}{2}\,d$

q not less than $(.6\,p + .4\,d)$

Hence H not less than $\sqrt{(1.1\,p + .4\,d)(.1\,p + .4\,d)}$

$B = 3\,d + H$

Where there are two or more rows of rivets they must be placed at a sufficient distance apart, so that there may be no danger of rupture along a zig-zag line, as indicated in the diagram. To this end the British Board

of Trade rules give certain values for the distance q as given before for this case. This distance is known as the *diagonal pitch*. The rules are derived from experiment. The distances resulting may be considered as the smallest allowable. In practice the values of q are often made somewhat greater than would result from the rules. Having selected the distance q, the location of the second row of rivets is easily found from the first by constructing a triangle with base equal to p, and the two other sides each equal to q. See Chap. I. (October issue, 1898).

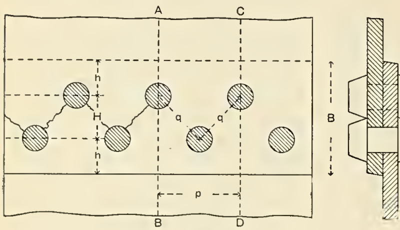

FIG. 6.

In this case the element $A\ B\ D\ C$ contains one whole rivet and two halves, or two rivets in all. We have then:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$
$$\textit{Strength of Rivets} = \tfrac{1}{2}\pi d^2 s$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 1.29\,\frac{d}{t}$$

$$\text{efficiency} = \frac{n - 1}{n} = \frac{1.29}{a + 1.29}$$

The values of $d \div t$ may vary through about the same range as in joint A, above, and for the same reasons as there explained. These operations may be expressed by a rule similar to that for joint A, the numbered sections referring to that rule as given above:

Rule:

(1) Same as for joint A.

(2) Use 1.29 instead of .645.

(3), (4), (5), (6) Same as for joint A.

(7) Take twice the strength of one rivet, found as for joint A.

(8), (9) Same as for joint A.

Example. To lay out a double riveted lap-joint for 1-2 inch plates, using 3-4 inch rivets.

$$\text{Then } \tfrac{3}{4} \times 1.29 \div \tfrac{1}{2} = \frac{3 \times 1.29 \times 2}{4} = 1.935$$

And $1.935 + 1.00 = 2.935$

And $2.935 \times \frac{3}{4} = 2.201$ = pitch.

Taking the nearest eighth above we have p = 2 1-4 inches.

Then taking strength of plate at 60,000, we have:

Strength of plate in joint $= (2\frac{1}{4} - \frac{3}{4}) \times \frac{1}{2} \times 60{,}000 = 45{,}000$.

Area of 3-4 inch rivet = .4418 sq. in.

Strength of rivets $= .4418 \times 2 \times 60{,}000 \times .821 = 43{,}520$.

Original strength of plate $= 2\frac{1}{4} \times \frac{1}{2} \times 60{,}000 = 67{,}500$.

Efficiency $= 43{,}520 \div 67{,}500 = .645$.

Similarly with 7-8 inch rivets, pitched 2 7-8 inches, the strength of plate and rivets will be nearly equal, and the efficiency will rise to .687.

Joint C. Lap Joint. Triple Riveted.

$$h = 1\tfrac{1}{2}\,d$$

q not less than $(.6\,p + .4\,d)$

Hence H not less than $\sqrt{(1.1\,p + .4\,d)(.1\,p + .4\,d)}$

$$B = 3\,d + 2\,H$$

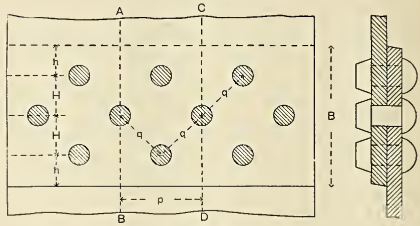

FIG. 7.

In this case the element $A\ B\ D\ C$ contains two whole rivets and two halves, or three rivets in all. We have then:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$
$$\textit{Strength of Rivets} = \tfrac{3}{4}\pi d^2 S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 1.935\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n - 1}{n} = \frac{1.935}{a + 1.935}$$

The values of $d \div t$ may vary through about the same range as in joint A, above, and for the same reasons as there explained. These operations may be expressed by a rule similar to that for joint A, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint A.

(2) Use 1.935 instead of .645.

(3), (4), (5), (6) Same as for joint A.

(7) Take three times the strength of one rivet found as for joint A.

(8), (9) Same as for joint A.

Example. To lay out a triple-riveted lap-joint for 1-2 inch plates, using 3-4 inch rivets.

$$\text{Then } \tfrac{3}{4} \times 1.935 \div \tfrac{1}{2} = \frac{3 \times 1.935 \times 2}{4} = 2.903$$

And $2.903 + 1.00 = 3.903$

And $3.903 \times \frac{3}{4} = 2.93$ inches = pitch.

Take $p = 3$ inches.

Then taking strength of plate at 60,000, we have:

Strength of plate in joint $= (3 - \frac{3}{4}) \times \frac{1}{2} \times 60{,}000 = 67{,}500$.

Area of 3-4 inch rivet = .4418.

Strength of rivets $= .4418 \times 3 \times 60{,}000 \times .821 = 65{,}280$.

Original strength of plate $= 3 \times \frac{1}{2} \times 60{,}000 = 90{,}000$.

Efficiency $= 65{,}280 \div 90{,}000 = .725$.

Similarly with 7-8 inch rivets, pitched 3 7-8 inches, the efficiency becomes .764.

Joint D. Lap Joint.

Triple Riveted, with rivets in inner row spaced one-half p.

$$h = 1\tfrac{1}{2}\,d$$

q not less than $(.3\,p + d)$

Hence H " " " $\sqrt{(\frac{11}{20}\,p + d)(\frac{1}{20}\,p + d)}$

$B = 3\,d + 2\,H$

As seen below, the efficiency of this joint is superior to that of joint *c*, but it is perhaps slightly inferior as

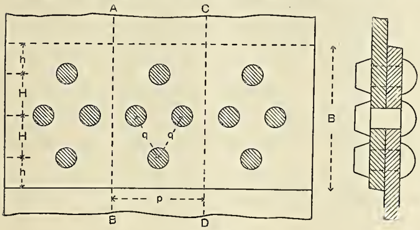

FIG. 8.

regards tightness against leakage. We have in this case:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$
$$\textit{Strength of Rivets} = \pi d^2\,S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 2.58\,\frac{d}{t}$$

$$\text{efficiency} = \frac{n - 1}{n} = \frac{2.58}{a + 2.58}$$

The values of $d \div t$ may vary through about the same range as in joint *A*, above, and for the same reasons as there explained. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 2.58 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take four times the strength of one rivet found as for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a triple-riveted joint as in *D* for 1-2 inch plates, using 3-4 inch rivets.

Then $\frac{3}{4} \times 2.58 \div \frac{1}{2} = \frac{3 \times 2.58 \times 2}{4} = 3.87$.

And $3.87 + 1.00 = 4.87$.

And $4.87 \times \frac{3}{4} = 3.65$ inches = pitch.

Take $p = 3$ 11-16 inches.

Then $\frac{1}{2}\,p = 1$ 27-32 inches.

Then taking strength of plate at 60,000 we have:

Strength of plate in joint $= (3\frac{11}{16} - \frac{3}{4}) \times \frac{1}{2} \times 60{,}000 = 88{,}125$.

Area of 3-4 inch rivet = .4418.

Strength of rivets $= .4418 \times 4 \times 60{,}000 \times .821 = 87{,}050$.

Original strength of plate $= 3\frac{11}{16} \times \frac{1}{2} \times 60{,}000 = 110{,}625$.

Efficiency $= 87{,}050 \div 110{,}625 = .787$.

With 7-8 inch rivets spaced 2 7-16 inches in the middle row and 4 7-8 in the outer rows, the strength of plate and rivets would be nearly equal, and the efficiency would rise to .81.

Joint E. Double Butt-Straps. Double Riveted.

$h = 1\frac{1}{2}\,d$

q not less than $(.6\,p + .4\,d)$

Hence H " " " $\sqrt{(1.1\,p + .4\,d)(.1\,p + .4\,d)}$

$B = 6\,d + 2\,H.$

Thickness of each butt strap not less than 5-8 the thickness of plate.

The arrangement of rivets is duplicated on either side of the joint line *P Q*. We need only to investigate the part of the joint on one side of *P Q*. The element is then *A B D C*, as in joint *B*, except that the rivets are in

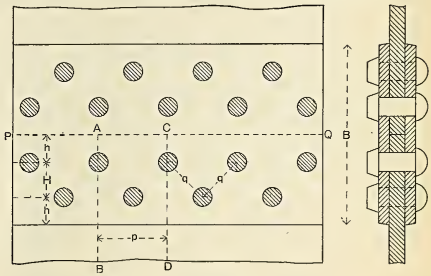

FIG. 9.

double shear instead of *single* shear. For the total shearing strength of a rivet in double shear, as previously explained, it is customary to take 1 3-4 times the strength for single shear instead of 2 times, or to take the two strengths in the ratio 7 : 4.

We then have:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$
$$\textit{Strength of Rivets} = \tfrac{7}{8}\pi d^2 S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 2.26\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n - 1}{n} = \frac{2.26}{a + 2.26}$$

In all double butt strap joints $d \div t$ usually varies from 1 to 1 1-4. The lower range of values, as compared with joints in which the rivets are in single shear, is required in order to insure the joint against danger of failure by crushing.

These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 2.26 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 3 1-2 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *E* for 1 inch plates, using 1 1-8 inch rivets.

Then $1\frac{1}{8} \times 2.26 \div 1 = \frac{9 \times 2.26}{8} = 2.54$.

And $2.54 + 1 = 3.54$.

And $3.54 \times \frac{9}{8} = 3$ 98 inches = pitch.

Take pitch = 4 inches.

Then taking strength of plate at 60,000 lbs., as before, we have:

Strength of plate in joint $= (4 - 1\frac{1}{8}) \times 1 \times 60{,}000 = 172{,}500$.

Area of 1 1-8 inch rivet = .994.

Strength of rivets $= .994 \times 3\frac{1}{2} \times 60{,}000 \times .821 = 171{,}350$.

Original strength of plate $= 4 \times 1 \times 60{,}000 = 240{,}000$.

Efficiency $= 171{,}350 \div 240{,}000 = .714$.

Similarly with 1 inch plates and 1 1-4 inch rivets, pitched 4 3-4 inches, the strength of plate and rivets will be about the same, and the efficiency is .737.

Joint F. *Double Butt Straps. Triple Riveted.*

$h = 1\frac{1}{2}\,d$

q not less than $(.6\,p + .4\,d)$

Hence H " " " $\sqrt{(1.1\,p + .4\,d)\,(.1\,p + .4\,d)}$

$B = 6d + 4H.$

Thickness of each butt-strap not less than 5-8 the thickness of plate.

The element of the joint is *A B D C*, as in joint *C*, except that the rivets are in double shear. Taking, as

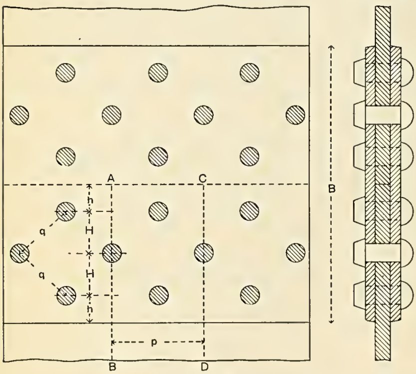

FIG 10.

before, the strength in double shear to that in single in the ratio 7 : 4, we have:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$
$$\textit{Strength of Rivets} = \tfrac{21}{16}\,\pi d^2\,S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 3.39\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n - 1}{n} = \frac{3.39}{a + 3.39}$$

In this joint $d \div t$ usually varies from 1 to 1 1-4, as explained for joint *E*. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 3.39 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 5 1-4 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *F* with 1 inch plates, using 1 3-16 inch rivets.

Then $1\frac{3}{16} \times 3.39 \div 1 = \dfrac{19 \times 3.39}{16} = 4.03$

And $4.03 + 1 = 5.03$.

And $5.03 \times 1\frac{3}{16} = 5.97$ inches = pitch.

Take pitch = 6 inches.

Then with strength of plate at 60,000, as before, we have:

Strength of plate in joint $= (6 - 1\frac{3}{16}) \times 1 \times 60{,}000 = 288{,}750$.

Area of $1\frac{3}{16}$ inch rivet $= 1.108$.

Strength of rivets $= 1.108 \times 5\frac{1}{4} \times 60{,}000 \times .821 = 286{,}500$

Original strength of plate $= 6 \times 1 \times 60{,}000 = 360{,}000$.

Efficiency $= 286{,}500 \div 360{,}000 = .796$.

Joint G. *Double Butt Straps. Rivets as in Joint D.*

$h = 1\frac{1}{2}\,d$

q not less than $(.3\,p + d)$

Hence H " " " $\sqrt{(.55\,p + d)\,(.05\,p + d)}$

$B = 6\,d + 4\,H$

Butt-straps to be of thickness not less than as given by the formula:

$$\text{Thickness of strap} = \frac{5\,(p - d)}{8\,(p - 2d)}\,(\text{thickness of plate})$$

The element of the joint is *A B D C*, as in joint *D*, except that the rivets are in double shear. Taking, as

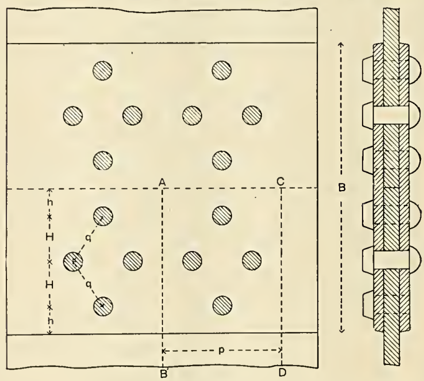

FIG. 11.

before, the strength in double shear to that in single shear in the ratio 7 : 4, we have:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$
$$\textit{Strength of Rivets} = \tfrac{7}{4}\,\pi d^2\,S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 4.52\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n - 1}{n} = \frac{4.52}{a + 4.52}$$

In this joint $d \div t$ usually varies from about 1 to 1 1-4, as explained for joint *E*. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 4.52 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 7 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *G* with 1 1-2 inch plates, using 1 5-8 inch rivets.

Then $1\frac{5}{8} \times 4.52 \div 1\frac{1}{2} = \dfrac{13 \times 4.52 \times 2}{8 \times 3} = 4.9$

And $4.9 + 1 = 5.9$.

And 5.9×1 5-8 = 9.6 inches = pitch.

Take pitch for outer rows 9 5-8 and for inner rows $4\frac{13}{16}$.

Then, with strength of plate at 60,000, we have:

Strength of plate in joint $= (9\frac{5}{8} - 1\frac{1}{2}) \times 1\frac{1}{2} \times 60{,}000 =$ 731,250.

Area of 1 1-2 inch rivet = 2.074.

Strength of rivets $= 2.074 \times 7 \times 60{,}000 \times .821 = 715{,}200$.

Original strength of plate $= 9\frac{5}{8} \times 1\frac{1}{2} \times 60{,}000 = 866{,}250$.

Efficiency $= 715{,}200 \div 866{,}250 = .826$.

Joint H. *Double Butt-Straps.*
Triple Riveted, with double spacing in outer row on each side.

$$h = 1\tfrac{1}{2}\, d$$

q not less than $.3p + .4d$

q_1 " " " $.3p + d$

Hence H " " " $\sqrt{(.55p + .4d)(.05p + 4d)}$

" H_1 " " " $\sqrt{(.55p + d)(.05p + d)}$

$$B = 6d + 2H + 2H_1$$

Thickness of butt-straps found by same formula as for joint *G*.

The element of the joint is *A B D C*, containing four whole rivets and two halves, or five in all. These are all

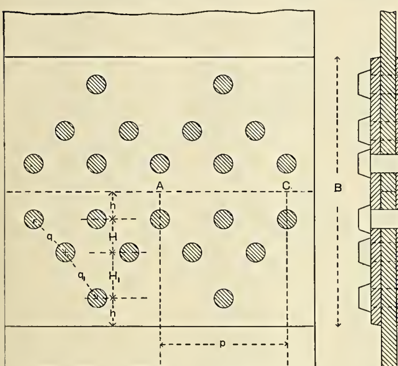

FIG. 12.

in double shear. Taking, as before, the strength in double shear to that in single in the ratio 7 : 4, we have:

$$\textit{Strength of Plate} = t\,(p - d)\,T$$

$$\textit{Strength of Rivets} = \tfrac{35}{16}\,\pi\, d^2\, S$$

For equal strength of plate and rivets:

$$\frac{p}{d} \text{ or } n = 1 + 5.64\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n - 1}{n} = \frac{5.64}{a + 5.64}$$

In this joint $d \div t$ usually varies from 1 to 1 1-4, as explained for joint *E*. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 5.64 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 8 3-4 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *H* with 1 3-8 inch plates, using 1 7-16 inch rivets.

$$\text{Then } 1\tfrac{7}{16} \times 5.64 \div 1\tfrac{3}{8} = \frac{23 \times 5.64 \times 8}{16 \times 11} = 5.9$$

And $5.9 + 1 = 6.9$.

And $6.9 + 1\frac{7}{16} = 9.92$ inches = pitch.

The limiting pitch by the Board of Trade rule for this case would be 9.87. This means that a pitch of 9.92 or larger would not be passed without special permission. If necessary to reduce below the limit, the joint should be redesigned with a smaller rivet. This case illustrates the point that these limiting values of the pitch, if rigidly adhered to, would prevent the attainment of the best joint efficiencies with thick plates. We shall here assume the right to proceed with the pitch derived from the formula which we will take as 10 inches for the outer and 5 inches for the inner rows.

Then taking strength of plate at 60,000 we have:

Strength of plate in joint $= (10 - 1\frac{7}{16}) \times 1\frac{3}{8} \times 60{,}000 =$ 706,400.

Area of $1\frac{7}{16}$ inch rivet = 1.623.

Strength of rivets $= 1.623 \times 8\frac{3}{4} \times 60{,}000 \times .821 =$ 699,600.

Original strength of plate $= 10 \times 1\frac{3}{8} \times 60{,}000 = 825{,}000$.

Efficiency $= 699{,}600 \div 825{,}000 = .848$.

Joint I. *Double Butt-Straps.*

Triple riveted, outer row on each side being double spaced, and passing through inside butt-strap only.

$$h = 1\tfrac{1}{2}\, d$$

q not less than $.3p + .4d$

q_1 " " " $.3p + d$

Hence H " " " $\sqrt{(.55p + .4d)(.05p + .4d)}$

" H_1 " " " $\sqrt{(.55p + d)(.05p + d)}$

$$B = 6d + 2H$$

$$B_1 = 6d + 2H + 2H_1$$

Thickness of butt-straps found by same formula as for

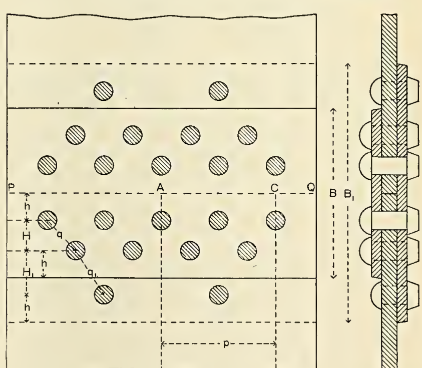

FIG. 13.

joint *G*. The element of this joint is *A B D C*, with four rivets in double shear and one in single shear. Taking,

as before, the strength in double shear to that in single in the ratio 7 : 4, we have:

Strength of Plate $= t\,(p - d)\,T$

Strength of Rivets $= 2\,\pi d^2\,S$

For equal strength of plate and rivets we have:

$$\frac{p}{d} \text{ or } n = 1 + 5.16\,\frac{d}{t}$$

$$\text{Efficiency} = \frac{n-1}{n} = \frac{5.16}{a + 5.16}$$

In this joint $d \div t$ usually varies from 1 to 1 1-4, as explained for joint *E*. These operations may be expressed by a rule similar to that for joint *A*, the numbered sections referring to that rule as given above.

Rule:

(1) Same as for joint *A*.

(2) Use 5.16 instead of .645.

(3), (4), (5), (6) Same as for joint *A*.

(7) Take 8 times the strength of one rivet, as found for joint *A*.

(8), (9) Same as for joint *A*.

Example. To lay out a joint as in *I* with 1 3-8 inch plates, using 1 7-16 inch rivets.

Then $1\frac{7}{16} \times 5.16 \div 1\frac{3}{8} = \frac{23 \times 5.16 \times 8}{16 \times 11} = 5.40$

And $5.40 + 1 = 6.40$.

And $6.40 \times 1\frac{7}{16} = 9.2$ inches = pitch.

We will take 9 1-4 for pitch of outer row, and hence 4 5-8 for pitch of inner rows. Then, taking strength of plate at 60,000, we have:

Strength of plate in joint $= (9\frac{1}{4} - 1\frac{7}{16}) \times 1\frac{3}{8} \times 60{,}000 =$ 644.530.

Area of $1\frac{7}{16}$ inch rivet = 1.623.

Strength of rivets $= 1.623 \times 8 \times 60{,}000 \times .821 = 639{,}600$.

Original strength of plate $= 9\frac{1}{4} \times 1\frac{3}{8} \times 60{,}000 = 763{,}125$.

Efficiency $= 639{,}600 \div 763{,}125 = .838$.

An examination of the values of the efficiency will show that these various joints for the same value of $d \div t$ stand, in this respect, in the order:

H, I, G, F, D, E, C, B, A.

THE ART OF MAKING MECHANICAL SKETCHES—FOR MARINE ENGINEERS—IX.

BY PROF. C. W. MAC CORD.

It has previously been stated that in making a drawing in which certain parts are cut by a given plane, it is not always necessary or even advisable to show in section other parts through which that plane would pass. This is further illustrated in Fig 38, which shows the lower part of a horizontal cylinder upon which is cast a supporting bracket, consisting of a foot-plate, connected with the cylinder barrel by two vertical webs at right angles to each other. At the end of the cylinder there is also a hub, which is drilled and tapped for a drain-cock. Clearly, the thickness of the barrel and the size of the flange are best shown by a section, the cutting plane being vertical and passing through the axis, which is parallel to the paper. Such a plane would pass through both the longitudinal web of the bracket and the hub. Were those parts shown in section, however, the support would at first glance present the appearance of a solid mass, as though it were formed by turning in a lathe (a form sometimes adopted), and the impression would be given that the *cylinder* was to be of great thickness just back of the flange, which again is not an impossible construction. Of course, by the use of dotted lines, the actual intention could be expressed; but by no means as clearly as it is in the figure. And this illustrates a rule to which there are few exceptions, viz.: that *a web parallel to the paper should not be shown in section,* even though a plane cutting other parts which must be so represented should be so situated as to pass through the web.

The structure of the bracket is shown by a sectional top view below it, the cutting plane being *m m,* and the form of the hub by a similar section through *n n.*

Reasoning very similar applies in the case of the hand-wheels shown in Fig 39, the upper one having four straight arms, and the lower three curved ones. It will be noted that the sectional view is the same for both, and that if *l l* be the cutting plane, it is not a rigidly correct representation of either. But it does show exactly what the workman wants to know, viz., the forms of the sections of the rim and the hub, and the thickness of the arms at their outer and inner ends; the breadth and the

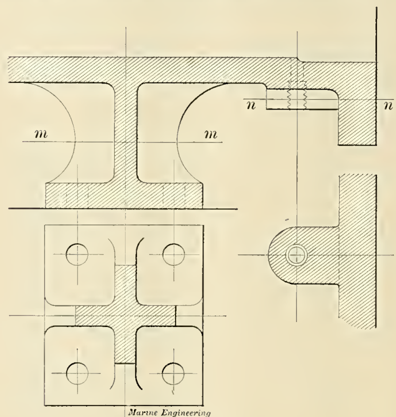

FIG. 38.

shape of the arms being shown in the other views. And this information is all that the sectional view *can* give that is of any practical value; and it is given more clearly and directly by making it as here shown than in any other way. An accurately constructed section by the plane *l l* would, in the case of the straight-armed wheel, look as though the rim and hub were connected by a solid web instead of by arms; and in the case of the other it would convey no information at all, except that the draughtsman presumably knew how to construct the section.

Since the arms *have* sensible thickness, they will in the end views either intersect or be tangent to the rims in curves, as *a b;* if the outer ends of the arms are filleted, these will be curves of tangency, and as imaginary lines not strictly entitled to representation; but it needs no argument to show that their introduction not only adds to the finish of the drawing but aids in giving a conception of the thickness of the arms. In a word.

they are useful, whether imaginary or not, and this practical value overrides theoretical abstractions. This mode of representation, it may be added, is applicable in other cases; thus, a pulley should always be cut at one side of an arm, and a gear wheel not only between two arms but between two teeth, whether an arm or a tooth does or does not lie so that the principal cutting plane passes through it.

In relation to the curved-arm wheel, it may be noted that the approximately elliptical form of the section of

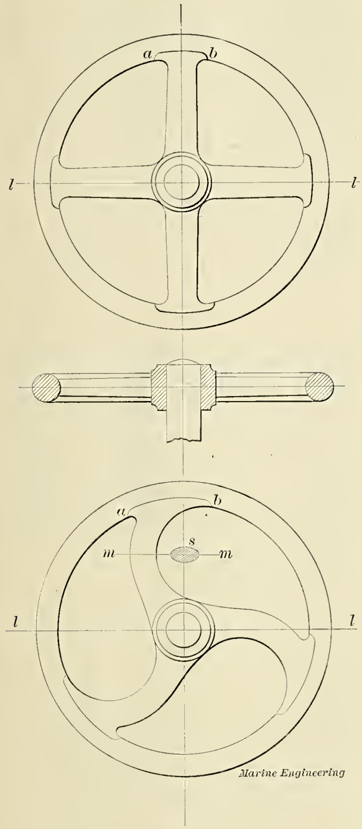

Fig 39.

the arm is shown at *s*, as if a thin slice were cut from the arm at *m m*, moved a little to one side, and revolved about its longer axis into the plane of the paper. A very common method is to draw this section directly upon the arm itself, but since this produces the same effect as though a side projection of that form were made upon the arm, the mode of representation shown in the figure is to be preferred.

In Fig. 40 there is given a working drawing of a small stuffing-box, with its gland and bolts. The form of the gland is clearly defined in the top view, and the case obviously requires a section of the stuffing-box by the plane *l l*, which accordingly is made in the figure. But in the side view, a section by this plane would not be perfectly explanatory, because it would be the same as though the flange of the gland, as well as that of the stuffing-box, were circular. But this is not the case; the gland is stiffened at its upper end by a narrow flange, out of which extend two lugs of the same thickness, through which the bolts pass. In order to convey in the

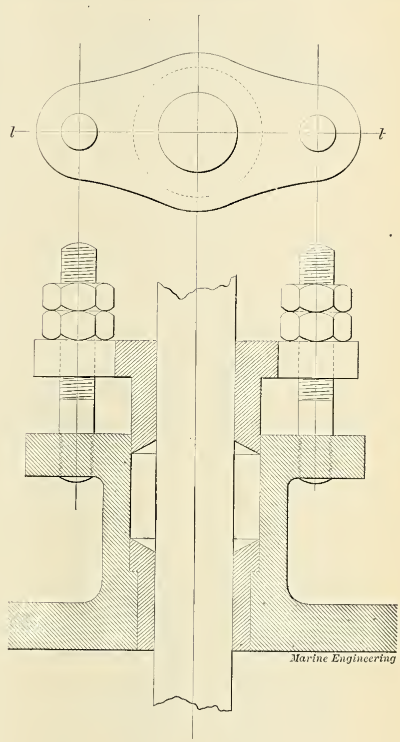

Fig. 40.

clearest manner the nature of this structure in the side view, a section of the gland and its flange by a plane perpendicular to *l l* is drawn, and the lugs and the bolts are shown in elevation.

This exhibits, in a more pronounced manner than any previous illustration, a disregard of the strict laws of making sections and projections. For these laws, when they interfere with practical utility, it will have been perceived that the present writer has a deep and well-founded contempt; the be-all and the end-all of a work-

ing plan is summarily comprehended in these two requirements, viz.:

1. That each view shall show as clearly as possible all that it can be made to show, *and no more than it can show clearly.*
2. That the drawing as a whole shall show what is to be made, *without the possibility of error.*

Applying this test, it is obvious that Fig. 40 satisfies both conditions; no mechanic, with this drawing before him, would be able to retain his position if he made a mistake.

Fig. 41 is a working drawing of a rubber pump-valve, with its central spool, sleeve, bolt, guard and grated valve-seat. The central figure is a section of all except the bolt and nut, by the vertical plane indicated by *l l* in the two top views. In regard to the valve-seat shown below the section, it is to be noted that on the right-hand side the plane *l l* cuts through one of the inner radial ribs; which, nevertheless, is *not* shown in section in the central view—in accordance with the principle or general rule mentioned in connection with Fig. 38. In this lower view the form of the head of the bolt, which is merely a square with the corners cut off, is distinctly shown, and corresponds exactly with the side view in the section. In relation to this drawing, particular attention is called to the fact that separate top views are given of the valve-seat and the guard. It is a melancholy, but still a too common sight, to see a single top view made to do service for both these; the hexagonal nut and the octagonal head of the bolt being drawn (the latter in dotted lines), the valve indicated by a full circle, above

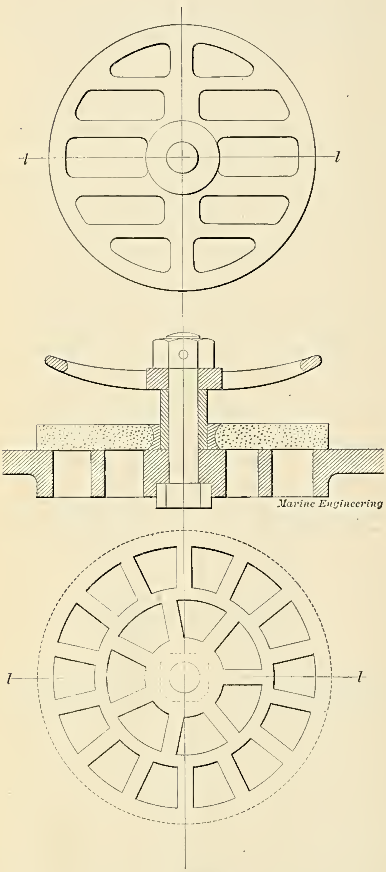

Fig. 41.

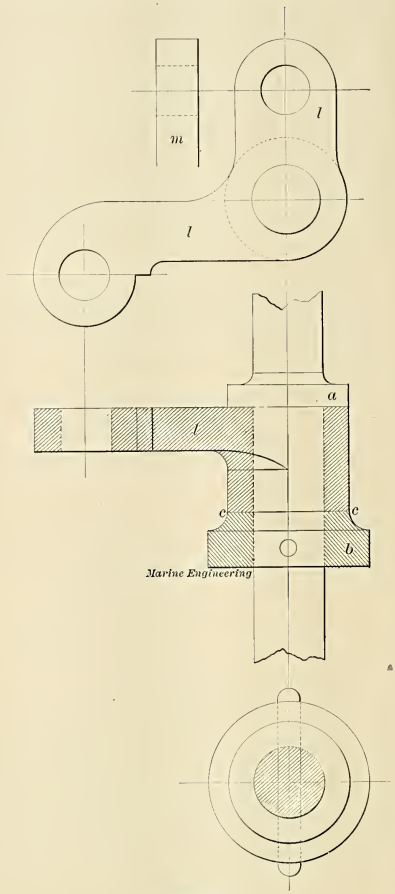

Fig. 42.

which the guard appears in full outline, while the sleeve, the spool, and the grated seating are shown, or rather obscured, by being drawn in dotted outline. The result is a small saving in the size of the drawing, at the expense of much confusion of lines and difficulty in reading the plan. This amounts to a small saving at the spigot and a large loss at the bunghole, as any "doubting Thomas" may easily convince himself by making the trial.

Fig. 41 also calls attention to this fact, that the circumstances of several pieces being shown in their proper relative positions in one view (in this instance the sectional one), is not an imperative nor always even a good reason why they should be so shown in other views. This is further illustrated in Fig. 42. We have here a portion of a vertical shaft, upon which is formed a collar, *a;* upon this shaft turns freely a bent lever, *l l,* kept in place by a "loose collar," *b,* which is pinned to the shaft. These three elements are shown in position in the central side view; but it is obvious that an attempt to represent this combination by a single top view would be anything but explanatory. A top view of the bent lever is shown above, and a side view, *m,* of the remote arm is also given, in order to show that its thickness is the same as that of the arm which points to the left; this is because the attempt to dot this in, in the side view below, would be very confusing, if not wholly unintelligible.

In this side view, it is to be noted, the formation of the lever *l l* is such that it is necessary to show it in *elevation,* the vertical shaft being dotted through both it and the collar *b.* We are here confronted by a new condition, because this collar, *b,* is finished on the upper side by a concave moulding, or fillet, by which its diameter is reduced to an exact equality with that of the hub of the lever *l l.* Were this view left simply as an outside view, or elevation, then it would be ambiguous, since the fillet line, *c c,* would leave it uncertain whether *l* and *b* were or were not separate pieces. This ambiguity is removed by a very simple expedient; having drawn the view as if in elevation, the two pieces, *l* and *b,* are "sectioned" in opposite directions; the sectioning lines are not to be *dotted,* but drawn in finely, regardless of the outlines of the elevation.

Finally, in order to show the form of the tapered pin which secures the loose collar to the shaft, there is given, below the side view, a top view of this pin, and of the loose collar, *b,* and of the shaft, as though the shaft were cut by a plane through *c c,* perpendicular to its axis. And by this selection and arrangement of views the whole combination is so clearly explained that it cannot be misunderstood.

The expedient of "sectioning" over the lines of an outside view is, in this particular case, introduced merely for the purpose of making clear the separation of one piece from another; but it will readily occur to the thoughtful reader that it may be employed with good effect in emphasizing the form of the section of a piece in which no actual ambiguity would result from its omission. But it is necessary to insist upon this, that on no account should the "sectioning lines" be *dotted,* notwithstanding the fact that the concealed outlines by which they are terminated are of necessity dotted in; the attempt to dot the section lines has often been made and as often has resulted in most lugubrious failure.

ENGINEERS' DICTIONARY.—XIX.

Gib—The *strap, gib* and *key* forms one of the methods of connecting the brasses for the bearing of a crank-pin to the connecting-rod, or in general for securing the brasses of any rotating pin joint connection to the rod or link. In Fig. 77 *AB* is the connecting rod, *CD* the brasses, and *EF* the strap. Through the rod and strap is a slot, as shown. *G* is the gib and *K* the key. The outer sides of the key and gib should be parallel and at right angles to the center line of the rod. The inner faces, which bear on each

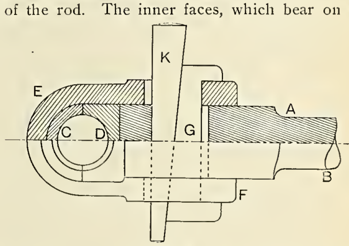

FIG. 77.

other, are inclined as shown. It is readily seen that with the key driven hard down the strap will be drawn over to the right, and the two brasses *CD* forced together to a bearing on the lines between them. Then as wear occurs and the pin becomes loose the lines may be thinned down and the key driven down further, until the brasses are again adjusted with the proper amount of clearance for smooth working. Similarly, if desired, the key can be backed up and the brasses loosened. The key is secured by a set-screw.

Girder-Brace—A form of brace used for supporting the top of the combustion chamber of a fire-tube boiler. They are known also as *crown-bars.* See under this term Fig. 41.

Gland—The part of a stuffing-box which is forced against the packing, thus compressing it and making

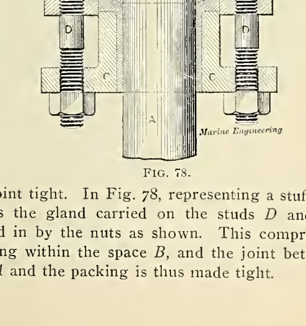

FIG. 78.

the joint tight. In Fig. 78, representing a stuffing-box, *CC* is the gland carried on the studs *D* and *D* and forced in by the nuts as shown. This compresses the packing within the space *B,* and the joint between the rod *A* and the packing is thus made tight.

NEW PUBLICATIONS.

Engine Room Practice. A Hand-book for Young Marine Engineers. By John G. Liversidge, Chief Engineer, Royal Navy. London, Charles Griffin; Philadelphia, J. B. Lippincott Co. First Edition, 1899. Size 5 1-2 by 8. Pages 292, with many drawings and engravings. Cloth, $2.50.

This book is one of the very few in which marine practice is treated in the manner it deserves, and it fully realizes the hope of the author that it may be useful to young engineers who are preparing for or entering on their career, and also to those other officers whose work and responsibilities are so intimately connected with the machinery of a modern steamship. The author (Chief Engineer in the British Navy) has demonstrated that he is perfectly familiar with the practice in the merchant marine, and the book ought to be of interest to all classes of seafaring engineers. The author states that the practice described in his book will not be that which is in use in every case, and that perhaps it is unnecessary to disclaim any pretense of superiority for the methods described, but that they are merely those which have been successfully used in certain instances. One could hardly expect that the experience of any one man could cover all cases, as, for instance, in the chapter on repair work where machine shop facilities enter largely into the question, but the methods shown will give an engineer a good understanding of the plan of procedure. The book is entirely free from all formulas which would puzzle the minds of the non-technical. Furthermore, it treats of practice which is distinctly up-to-date and makes a specialty of the auxiliary machines, which are of such great importance nowadays and which are so uniformly neglected in most treatises on marine work.

The first chapter treats of the different types of main and auxiliary engines, advantages of twin screws, and tables of comparison in the advance of practice in the British Navy and several well-known steamship lines. Several chapters are then devoted to the condition of service of engineer officers, Royal Naval and Royal Naval Reserve, and in the leading steamship lines, size of crew, duties and routine of service.

The next chapter treats of raising steam, giving all the minute details, both in the engine room and boiler room, such as starting forced draft fans, trying steering gears and telegraphs and preparing the lubricating gear, manipulating the drains, etc. Then follows the duties of a steaming watch, both in the engine and boiler rooms, and a description of all the details that require attention and observation, followed by a chapter of instruction on shutting off steam. The details of harbor duties are then described, both for the navy and merchant marine, followed by an extremely interesting chapter on repairs and adjustment of machinery. The refitting, taking leads and adjustment of bearings are described, as well as different methods of taking machinery adrift and the handling of the parts, also advice as to where to look for wear in certain parts, adjustment of different styles of metallic packing and testing for leaks in the condensers, also all the work done in dry dock, such as grinding of valves, zinc protection and examination of outboard shafting.

The article on preservation and repairs of boilers is exceptionally good, as it goes into details as to the various methods of patching and repairing Scotch boilers, the method of dealing with cracks in plates, repairing and renewing leaky stays, and the handling of tubes and stay tubes.

The next chapter deals with the hull and its fittings, main drains from double bottoms, sluice and flooding valves and the methods of clearing, painting and preserving the hulls, double bottoms and bunkers, and the different paints, cement and compositions used.

Then follows a detail description of all the auxiliary machinery, beginning with the different well-known styles of pumps, their treatment, irregularities, and adjustments. Then the different styles of feed heaters, feed water regulators, and evaporators are shown. The running and care of the dynamos and electric engines is well described, also the hydraulic and air compressing machinery.

The chapter on refrigerating machinery covers the dry air, the carbonic anhydride, and the anhydrous ammonia refrigerators, describing their advantages, disadvantages and their treatment.

The last chapter deals with the description and handling of machinery and boilers of torpedo boat destroyers, and also instruction in the handling of Belleville water-tube boilers.

The appendix contains the requirement for the entry and the training of Assistant Engineers of the Royal Navy and examples of examination questions for the rank of engineer and chief engineer of the same service.

This book is well illustrated and the illustrations are easy to understand, and they bring out the points in question very distinctly. Although there are only a few types of American auxiliaries described, English and American marine practice are so closely allied that the dividing line can hardly be drawn, and with the exception of several auxiliary outfits which are not often seen on American vessels, but which are the same in principle, the American marine engineer will find the book well worthy of close study.

"Report of the Commissioners and a History of Lincoln Park, Chicago," is the title of a beautifully illustrated volume, which in artistic make-up, illustrations and typographical excellence is superior to anything of the sort that has ever come under our notice. Annual reports are not usually interesting documents, but in this instance the compiler, I. J. Bryan, Secretary to the Commissioners, has produced a document which is of the greatest interest. There is an extended reference to the great storm of October 25, 1898, on Lake Michigan, which did great damage to the Park beach and esplanades. An excellent series of protographs show the tremendous power of the waves even in these inland waters. Complete details of the beauties, both natural and acquired, of the Park are given, a free use being made of excellent half-tone illustrations. The Commissioners of Lincoln Park have shown fine enthusiasm in their work by the production of this report.

The September issue of *The Engineering Magazine*, New York, contains the second installment of the very interesting article on "The Development of German Shipbuilding," by Rudolph Haack. This installment, which is very handsomely illustrated, treats chiefly of the shipyards on the North-Sea coast.

MARINE ENGINEERING.

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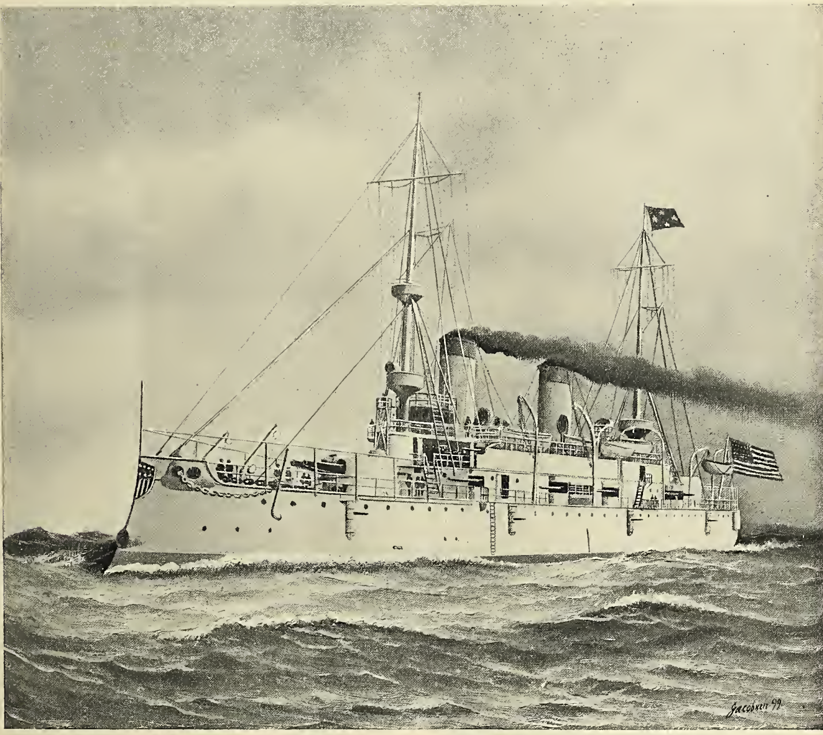
HOME COMING OF THE FLAGSHIP OLYMPIA WITH ADMIRAL DEWEY.

About the time of publication of this issue New York will be ablaze with illuminations by night and gay with decorations by day welcoming home Admiral George Dewey, U. S. N. A tremendous welcome has been prepared by the American people at the first home port which the modest victor of the Manila sea fight will arrive at. There will be a naval review and a large parade, besides banquets and other indoor festivities for the officers and men of the flagship *Olympia* Our artist has made an exact sketch of the homecoming vessel which we here present. In our last issue we gave details of the construction and equipment of the vessel which is a twin screw protected cruiser of about 6,000 tons displacement. The homeward voyage of the *Olympia* was commenced September 11, from Gibraltar, where Admiral Dewey and his men were given a very hearty reception by the British land and naval forces. The *Olympia* is a product of the Union Iron Works, San Francisco.



U. S. PROTECTED CRUISER OLYMPIA ON HER WAY HOME FROM MANILA WITH ADMIRAL DEWEY.

CONSIDERATION OF THE STEAM YACHT FROM THE DESIGNER'S POINT OF VIEW.—I.

BY WILLIAM A. FAIRBURN.

For the past twenty years steam pleasure craft have been gradually ascending the scale of popularity. Year by year ardent yachtsmen have been abandoning their sailing vessels for larger and costlier steam yachts. There are very few moneyed men to-day who are such enthusiastic yachtsmen that they prefer the sailing yacht, although for genuine yachting sport it must be confessed that the latter will probably always have supremacy. The steam yacht is to-day a very popular vessel. Not only do seafaring men take an interest in her, but landsmen are at once attracted by her rakish, graceful and handsome appearance. The possession of a steam yacht denotes the wealth of the owner, and partly for this reason steam yachts are very popular with moneyed men. In these days the size of a gentleman's steam yacht is generally proportional to his bank account, and quite a large number of millionaires at present seem to vie with each other in the ownership of magnificent, luxurious and speedy floating palaces.

Although the term steam yacht signifies a pleasure craft propelled by steam, yet the term as popularly used refers to steam pleasure craft larger than the cockpit or open launch. While no hard and fast rule as to size can be laid down, it may be stated that, generally, the "launch" is less than 55 or 60 ft. long and the "yacht" is a longer vessel. The launch is generally open to the weather, while the yacht has inclosed accommodation. Usually the launch has a perpendicular bow, while the yacht almost invariably has a long, tapering, overhanging, clipper stem. Ignoring for the present the launch type of "steam yacht," we may say that the modern steam yachts can be divided into five classes: I—Full powered seagoing steam yachts. II—Seagoing steam yachts with sail auxiliary. III.—Seagoing sail yachts with steam auxiliary. IV—Coastwise steam yachts. V—Coastwise auxiliary steam yachts.

Until the past few years there were very few vessels of Class I afloat, but, as before mentioned, of late years a great rivalry among moneyed men for the possession of the finest, largest and speediest steam yacht afloat seems to have sprung up, the result being that year by year larger and faster seagoing full powered steam yachts are being constructed. Some of the most modern vessels are veritable ocean liners, and they represent the most modern and most approved methods of marine construction. The *Valiant*, owned by W. K. Vanderbilt and built by Laird Bros., of Birkenhead, England, from designs by St. Clare Byrne of Liverpool, is the largest full powered seagoing steam yacht afloat—excluding a few vessels (mostly of the cruiser type) owned by the crowned heads of Europe. The *Valiant* was built in 1893, her length between perps. being 310 ft.; beam, 39.3 ft.; depth, 25.6 ft.; tonnage, about 2,400 tons. She is a twin screw vessel of about 5,000 I. H. P. and 17 knots speed. The *Mayflower* and *Nahma*, with tonnage of 1,780 tons and waterline length of 275 ft., were built at Clydebank, Scotland, in 1896-7 for Ogden and G. Robert Goelet, of New York, respectively, from designs by Gen. L. Watson, of Glasgow. The sudden death of Ogden Goelet was the cause of the *Mayflower* being offered for sale. The U. S. Navy Dept. early in March, 1898, purchased her for about $400,000, converting her into a despatch and special service vessel. These boats are very fine, powerful twin screw vessels of 4.600 I. H. P. and 16.75 knots speed. The *Varuna*, of 260 ft. waterline length and 16.75 knots speed, was built by A. &. J. Inglis, of Glasgow, Scotland, for Eugene Higgins, of New York, from designs by G. L. Watson, in 1896. She is a smaller *Mayflower*, and is of about 1,500 tons measurement. The *Margarita II*, of 239 ft. w. l.; 3,400 I. H. P.; 16 1-2 knots speed, was built at Troon, Scotland, about the same time, for A. J. Drexel, of Philadelphia, from the plans of the same designer. The *Margarita II*, is a handsome vessel, but Mr. Drexel, finding that she was smaller than he desired, placed the order for a large, palatial steam yacht of about 1,800 tons with G. L. Watson & Co., Glasgow, a few months ago. This vessel is now being built by the Scotts, of Greenock, Scotland. She is 272 ft. long and 36 ft. 6 in. beam, and is of special interest owing to the fact that she will be the first yacht owned by an American under the recently enacted law, which requires him to pay entrance and clearance fees at every port in the United States which his yacht visits, the same as any foreign merchant vessel owner. A year ago Scott & Co., Greenock, Scotland, completed a magnificent vessel of this type named the *Aegusa* for Commendatore Ignazio Flori, of Italy. She has a w. l. length exceeding 250 ft.; beam, 31 ft. 6 in.; depth, 20 ft. 6 in., and is 1,243 tons register. A single screw with triple expansion engines of 2,500 I. H. P. gave the vessel a trial speed of 16 1-2 knots. This vessel has quite recently been purchased by Sir Thomas Lipton, the British challenger for the America's Cup, and rechristened the *Erin*.

The finest specimen of a full powered steam yacht afloat was the *Giralda*, but she is now a despatch vessel, having been purchased by the Spanish Government just previous to the commencement of the Hispano-American war. She does not excel in appearance any of the yachts before mentioned, but power, strength and seaworthiness are her striking characteristics. "Did you ever see such an enormous smoke-stack in your life?" was the first remark generally made by yachtsmen when inspecting her.* She certainly has an enormous stack, and the grace of the hull which it overtops somehow seems to intensify its appearance of bulk. Below deck, one-half the vessel's length is occupied by machinery, although the athwartship bunkers are very small indeed. She is a twin screw vessel with vertical triple expansion engines, which on trial developed 8,500 I. H. P. at 220 revolutions, giving the vessel the remarkable rate of speed of 20.9 knots. Steam is supplied by three double and two single ended Scotch boilers at 170 lbs. pressure, working with closed stokeholds. The *Giralda* combined the principal features of a pleasure craft and a cruiser, and when commanded by her original owner, Harry McCalmont, it is said that sixty members of the British Naval Reserve composed the vessel's complement. She is 275 ft. long on the water, 312 ft. over all, 35.2 ft. beam, 19 ft.

* In the case of yachts the size of the stack is often no indication of the power of the vessel. Funnels of excessive outside dimensions are not unusual, to give an "appearance" of power.—ED. M. E.

deep and 1,508 tons register. The *Giralda* was built and designed by the Fairfield Co. of Glasgow, in 1894. This company is also well known as the builder of Baron Edmund De Rothschild's yacht *Atmah* (built eighteen months ago) which was recently sold. She is 280 ft. long on the water line, 34 ft. beam, and has a speed of 15.75 knots.

One of the most graceful, handsome and successful full powered steam yachts afloat to-day, and one that has been greatly admired by all yachtsmen who have been fortunate enough to inspect her, is the Watson designed yacht *Rona*. She was built by D. & W. Henderson, of Glasgow, for Arthur H. E. Wood, of England, in 1895. She has a light brigantine rig and is 243.7 ft. long, 30 ft. beam, 18.25 ft. depth of hold, the loaded draft being 16 ft. and tonnage 1,053 tons. On trial she averaged 15 knots speed on a 27 knot course. The latest American built full powered seagoing steam yachts are the 300 ft. over all *Corsair*, contracted for by the W. & A. Fletcher Co., of Hoboken, N. J., for J. Pierpont Morgan, and P. A. B. Widener's new *Josephine*, recently completed by Neafie & Levy, of Philadelphia. The latter vessel is very roomy and very high-sided for her length. Her designed speed is 17 knots.

It would be uninteresting to enumerate more vessels of this type, as quite a number of full powered steam yachts with waterline lengths varying from 200 to 250 ft. have been built during the past few years. James Gordon Bennett, of the New York "Herald," a few months ago commissioned Mr. Watson to design a palatial twin screw steam yacht, which, while having all the characteristics of such craft (fineness of form and luxuriousness of living accommodation), should be able to carry sufficient coal to enable her to cross the Atlantic at a much higher speed than has hitherto been thought possible in such craft without in some way recoaling. At present the record in this matter is, if the writer is not mistaken, held by the *Varuna*, which, nearly two years ago, accomplished this voyage at an average speed of 13 1-2 knots. Mr. Bennett's new yacht is now being constructed by W. Denny & Bros., of Dunbarton, Scotland. Mr. Bennett's present yacht is the *Namouna*, built in 1881 at Newburgh, New York. She is still a fine vessel of 616 tons and 216 ft. w. l. length.

In Class II—seagoing steam yachts with sail auxiliary—we find that these vessels have a speed under steam alone of about 12 to 14 knots, and usually they are fitted with about 2-3 full sail power. The finest and most successful vessel of this type afloat is probably the barque-rigged single screw yacht *Eleanor*, designed and built by the Bath Iron Works, Bath, Me., C. R. Hanscom, general superintendent, for William A. Slater, of Norwich, Conn., in 1893. This vessel has circumnavigated the globe and steamed over 100,000 miles without an accident and with hardly a dollar being spent in repairs. There are very few finer looking vessels than the *Eleanor* afloat to-day, for, although her stern is much too heavy for appearances, it must be remembered that she was designed seven years ago primarily for a deep sea cruiser, and her form and arrangement for service and utility have been greatly admired by seafaring men. The *Eleanor* is 208 ft. on the water line, 32 ft. beam, and has a speed of 13 1-2 knots under steam alone. Her average speed under steam across the Atlantic on one occasion was 12 1-2 knots, and using both sail and steam she has logged 14 1-2 knots for days. One of the latest American built steam yachts which might be considered as belonging to this type of pleasure craft is Archibald Watt's twin screw steam yacht *American*. She is ship rigged, a freak in many respects, but certainly no yacht in appearance or proportions. The *American* is the result of a millionaire's whim. The owner, having considerable money, decided to build a yacht from his own design, and he chose to do this rather than to consult expert designers and experienced shipbuilders. The *Niagara*, a twin screw yacht recently completed at the yard of Harlan & Hollingsworth, Wilmington, Del., for Howard Gould, is another modern vessel of this type. She is also barque rigged and has a water line length of 245 ft.; length over all 270 ft.; beam 36 ft., and a speed of about 14 knots. Few vessels of this type have been built, for most yachtsmen seem to prefer speed. A large sail spread with a favorable breeze does very little to increase a vessel's speed, while the spars, sails, and rigging add considerably to the resistance of the vessel, especially at high speeds with a head wind. Therefore the tendency of late years has been to put into these vessels more engine power and reduce the said spread. Almost all full powered steam yachts have more or less canvas, but it is usually carried to give steadiness and comfort in a seaway, and not to be used in propulsion. The *Valiant* is brig-rigged, but with a fair wind her speed is only increased a small fraction of a knot by the use of her canvas.

Vessels of Class III—sail with steam auxiliary—are usually rather small. There is, however, one large modern vessel of this type afloat, the *Valhalla*, owned by Joseph F. Saycock of the Royal Yacht Squadron, England. She is the largest vessel of her kind in the world and she has attracted a good deal of attention from yachtsmen on account of her large size, full ship rigging, and handsome appointments. The *Valhalla* depends almost entirely on her sails as a means of propulsion, and her steam equipment is for use only in case she becomes becalmed. She was built in 1892, and is 239.6 ft. long over all, 37.2 ft. beam, 20.7 ft. deep. Her mainmast is 141 ft. long and her mizzen mast 125 ft. long. She presents a very shipshape appearance, but yet one cannot say that she looks yachty. Perhaps no vessel of this type has become better known throughout the world than the old composite auxiliary steam yacht *Sunbeam*, designed by St. Clare Byrne for Mr. (now Lord) Brassey, and built by Bowdler, Chaffers & Co. of Seacombe, England, in 1874. She is 180 ft. long over all, 27 ft. 6 in. beam and 13 ft. 6 in. draught. On trial her compound engines developed 380 I. H. P., which gave the vessel a speed of 10 1-4 knots. She is fitted with a Bevis's patent feathering propeller, as is usual with vessels of this type. She has a fore and aft rig, her longest mast, deck to cap, measuring 80 ft., and her total sail area is about 12,000 sq. ft. She is ballasted with lead between the floors. In the famous voyage of the *Sunbeam*, so pleasantly told by the late Lady Brassey in her published work, this successful vessel circumnavigated the globe, accomplishing in her cruise 35,450 miles, of which 20,400 were under canvas

alone. The *Sunbeam's* best day's sailing was 299 miles, and her best day's steaming was 230 miles. The British auxiliary steam yacht *Lancashire Witch*, entirely under canvas, made the distance 4,458 miles, from the Falkland Islands to Natal, in 23 days. Her best day's sailing was on a voyage to Yokohama, when she covered 295 miles in 24 hours. Her best day's steaming was 216 miles. The advantage of an auxiliary steam vessel may be therefore very considerable in extended voyages where the trade winds can be made use of, and even in head winds if she is a fairly weatherly vessel. The *Arcturus*, designed by St. Clare Byrne for Rutherford Stuyvesant of New York and built by Ramage and Ferguson, Leith, Scotland, in 1896, is a fine modern vessel of this auxiliary type. She is schooner-rigged; 169 ft. over all; 135 ft. on the water; 27 ft. beam, and 13 ft. draught. She is fitted with an engine of 500 I. H. P. and two Almy water tube boilers, and on the measured mile she attained a speed of 11.75 knots. The *Lady Torfrida, Intrepid, Utowanga* and *Sultana* are fine vessels of this type, and the American wooden yacht *Sagamore* is yearly adding to her laurels as a highly successful auxiliary barkentine-rigged steam yacht. Some yachtsmen have proclaimed Lord Phoenix's yacht *Intrepid* to be the finest auxiliary cruiser afloat. The majority of these vessels have a fore and aft rig and the height of the spars increase as they go aft. This feature certainly does not improve their appearance. Many vessels of this type are somewhat tender, the hulls lacking power and the vessels being over-canvased.

Class IV—coastwise steam yachts—contains hundreds of smaller steam yachts ranging up to 150 ft. waterline or even longer. Many long steam yachts would have to be classed under this heading owing to their proportions and very limited endurance. It is impossible, however, to draw the line between the coastwise and the ocean-going steam yacht, for many a vessel that is seldom out of sight of the American shore is quite capable of making an extended ocean voyage. The smallest steam yacht, excluding the sloop *Alice* and J. G. Cassatt's old yacht *Eugenia*, to cross the Atlantic, is the *Sylvia*, owned by E. Y. Brown of New York. She was built by A. Stephen & Sons of Glasgow in 1882, and is 130 ft. long on the water, 18 ft. 6 in. beam and 10 ft. 10 in. draught. This yacht left Queenstown December 20, 1894, with forty tons of coal on board. The run to Funchal, Madeira, was made in 5 days 12 hours, and after coaling the *Sylvia* proceeded on her journey to Bermuda, which was reached January 10. One day was spent in coaling, and on January 15 Sandy Hook was sighted. The average revolutions for the voyage were 93; the coal consumption per day was 4 1-2 tons, and the distance covered, Queenstown to New York, was 4,636 miles, the time occupied being 20 days 22 hours. It appears, therefore, that a 130 ft. steam yacht of British proportions is capable of crossing the Atlantic, and is therefore considered a seaworthy vessel. It must be remembered, though, that the commander, Captain Arthur H. Clark, went through experiences which few men would care to undergo. The officers and crew deserted the ship at Waterford, Ireland, refusing to make the voyage in so small and unseaworthy a little vessel. On account of her small endurance it will be seen that the vessel had to steam over 4,600 miles instead of 2,800 miles—the direct course.

The *Sylvia* is a typical British coasting steam yacht, for although somewhat old her characteristics are about the same. The *Neckan, Free Lance, Illawarra, Aileen, Embla, Idalia, Formosa, Eugenia* and *Peregrine* can be looked upon as representative American built steam yachts of this type. But these vessels have no similarity. Each designer has his own peculiar ideas. There are no national characteristics, as is the case of the British smaller yachts, and one can only describe them as something different from the British boats.

The *Ituna* and *Hermoine*, British steam yachts now owned by Americans, are representative vessels of the British medium size coasting type. Of the larger type, which border on Class I—full powered sea-going yachts—the *Conqueror, Narada, Andria* and *Sapphire* are representative vessels of British design, while the *Columbia, Nourmahal, Alberta, Sovereign, Kanawha* and the old *Corsair* and *Josephine* represent the work of American designers. It will be remembered, however, that a few of these yachts were purchased during the late war by the U. S. Navy Department, and therefore they can be classed as steam yachts no longer.

Class V—coastwise auxiliary steam yachts can almost be ignored, as the vessels of this type must necessarily be small. An auxiliary yacht to be successful must have proportions which tend to give her great sea-keeping capabilities, and therefore auxiliary steam yachts as small as 80 ft. waterline length may be classed as ocean-going. The American built auxiliary yacht *Wild Duck* of 125 ft. waterline, and 23 ft. 3 in. beam, is quite famous, as is also the British-built *Satanella*, late *Golden Fleece*, of 113 ft. 6 in. waterline and 22 ft. 6 in. beam. These boats, although but a little over 100 tons burden, have made extensive ocean cruises. The British auxiliary screw schooner *Water Lily*, built by Day, Summers & Co. of Southampton is another representative vessel of this smaller auxiliary type. She is 119.8 ft. long and 23.4 ft. beam, and is now owned by George F. Muntz.

White Star Liner Oceanic.—The maiden trip of the White Star Liner *Oceanic*, which begun at Liverpool September 6, was completed at New York September 13. The time from Daunt's Rock to Sandy Hook light was 6 days, 2 hours and 37 minutes. The best day's average was on the fourth day out, when the vessel maintained a speed of 20 1-2 knots. The daily runs were: 443, 470, 457, 496, 483 and 431 knots. The ship behaved splendidly on the trip, being exceedingly steady, and the machinery worked perfectly. The engineers' department labored under the disadvantage of having a green crew aboard, owing to a strike which prevented the shipment of an experienced crew of stokers at Liverpool. Among the passengers was the Right Honorable W. J. Pirre, of the firm of Harland & Wolff, the builders. It is understood that on the next voyage an attempt will be made to lower her time, although the expectation of the builders and owners is that she will not be a flier, but will be able to make her trips with train time punctuality.

The new transatlantic liner *Lorraine* for the Havre-New York service of the Compagnie Generale Transatlantique (French Line) was launched recently at St. Nazaire, France. The new vessel is 580 ft. long, and it is understood that she will have a sea speed of 22 knots.

INCREASING DIMENSIONS OF FREIGHT STEAMSHIPS IN TRANSATLANTIC TRADE.*

BY G. B. HUNTER.

Since 1891, and more especially since 1894, there has been a great increase in the size of cargo steamers employed in the Atlantic carrying trades. This has been largely due to the foresight and enterprise, first, of Harland & Wolff and the owners of the White Star Line, of Liverpool, and more recently of R. S. Briggs and R. M. Hudson, Sunderland; Sir Christopher Furness, and Elder, Dempster & Co.[1] There is practically no limit to the size of cargoes that can be obtained in America. It is remarkable that until 1895 there were no British cargo steamers of more than 6,500 tons gross register, except the *Bovic,* 6,583 tons gross register, and *Cevic,* 8,301 tons gross register, of the White Star Line, built by Harland & Wolff in 1892 and 1893; the *Samoa,* 6,839 tons gross register, and *Maroa,* 6,802 tons gross register, owned by Crow, Rudolph & Company, Liverpool, and built by W. Doxford & Sons in 1892 and 1894—and always excepting the *Great Eastern.*

Of merchant steamers (both for cargo and passengers), 6,000 tons gross register and over, according to a return of Lloyd's registry, there were building in March, 1895, ten vessels, and in March, 1899, fifty-four. Among the largest cargo, or partly cargo, steamers now building are the *Saxonia* and *Invernia,* of about 13,200 tons gross register, for the Cunard Company, by the Clydebank Shipbuilding Company, Limited, and C. S. Swan & Hunter, Limited, respectively. Of merchant steamers, 10,000 tons gross register and over (cargo and passenger), there are now building in British yards eighteen vessels, including the *Oceanic,* about 17,000 tons; in German yards, nine; and in French shipyards, two vessels.

To illustrate the rapidity with which cargo steamers have been increased in size, and also the increasing adoption of twin screws, the following table from a paper read by E. W. de Russett, M. Inst. C. E., before the Institution of Civil Engineers, with a slight addition, is given (all the more recent steamers were built for the Atlantic trade):

PARTICULARS OF SOME OF THE LARGEST ENGLISH CARGO STEAMERS.

Year.	Name.	Dimensions. Length	Bre'dth	Depth	Tonnage. Gross.	Water Ballast	Screw.
		Ft. B. P.	Ft. In	Ft. In		Tons.	
1891	Chancellor........	400	47 6	31 6	4,753	831	Single.
1892	Tokomaru........	425	53 0	34 0	6,237	1,310	"
1894	Aotea.............	430	49 0	32 10	5,652	1,073	"
1895	Westmeath........	450	56 0	34 6	6,850	1,555	"
1896	Milwaukee........	470	56 0	34 10	7,317	2,555	"
1897	Monarch..........	470	56 0	34 10	7,295	2,592	"
1898	Mount Royal......	470	56 0	34 10	7,041	3,590	"
1898	Ultonia...........	500	57 4	37 0	8,056	2,659	Twin.
1899	Saint Andrew.....	470	56 0	34 0	6,900	3,234	
1899	Invernia.......... (building)	580	64 6	41 6	13,200 about	4,550	"

Instead of singling out an existing steamer for description, some leading features of a typical American freight steamer of the present or early future, for carrying large cargoes across the Atlantic economically and safely, on a moderate draught was discussed. With docks, harbors, and markets, as they are and will be, such a vessel might be designed to carry not less than 12,000 tons deadweight, with cubic capacity for 20,000 tons of cargo at 40 feet per ton, and 1,000 tons of fuel. This would require dimensions approximately as follows: Length between perpendiculars, 500 ft.; breadth, 60 ft.; depth, moulded, 36 ft. to main deck; 44 ft. to shelter deck. The draught of water loaded would be about 27 ft. 6 in.

The development of the Atlantic cargo steamship will be on ship-shape lines, and not in the way of fantastic patent ships. There should not be more than three complete decks, including a shelter deck, with a partial fourth deck in forehold only. The shelter deck is practically necessary for the American trade. The space covered by the shelter deck must necessarily be exempt from measurement for tonnage dues, except when used for freight or cattle. It is reasonable and necessary that it should be so treated, because it is not required for heavy cargoes, and adds greatly to the surplus buoyancy and freeboard, and to the safety of the ship and crew; while the expense of paying tonnage dues on this space, when not carrying freight in it, would be practically prohibitive. With a complete shade deck there is no need for the further addition of a long bridge house, either for more space or for safety, and such further erections are undesirable. Nothing more is advantageous above the shelter deck, in a cargo steamer, than houses for the accommodation of the officers, and for sheltering the steering gear; with steering house and chart house 8 ft. above the deck and pilot bridge 15 ft. above it. With these the height from the keel to the pilot bridge will be about 60 ft. As an instance of a greater height, plans have been submitted to his firm for building a steamer over 90 ft. from the keel to the top of the steering house.

The specifications should not be allowed to include any items that will not earn 20 per cent. per annum on their cost, to cover insurance, depreciation, interest, and profit. The steel decks need not be sheathed with wood, neither should wood sheathing be fitted on the double bottom. He might pass over the question of cargo discharging appliances, beyond saying there is no need for a donkey boiler, and there should be not less than twelve to fifteen steam winches of the best description. It is a question for consideration whether there should be any masts, sails, etc., or not.

As regards strength, his experience has been that with good work, Lloyd's scantlings for large steamers, with some little additions, have proved sufficient for Atlantic weather. The largest ships they had built had proved perfectly strong enough, after three or four years' work. Further experience is required to prove whether the larger steamships built on the present rules will stand

* A paper read before the Institution of Naval Architects, and published in the *Engineers' Gazette*, England.

1 The author strangely ignores the enterprise of German steamship lines in this direction. There are many more steamships of 10,000 tons and upwards sailing under the German flag than under the British. His explanation would probably be that they are not exclusively cargo vessels.—ED. M. E.

ten years' heavy Atlantic work equally well. It is probable that they will. Those built by his firm are stronger in the shelter deck than Lloyds' rules require, but in other respects some of them are built simply to the rule scantlings. Of course it is necessary to pay special attention to the strengthening of deck and side openings, and to any places such as the ends of bridge deck house and the corners of hatchways, where there is a sudden termination of a rigid structure, or concentration of stresses. The number of rivets, spacing, and size, also require special attention. The attachment provided by the latest rules for the frame-feet to the margin plates of the double bottom is insufficient and should be greatly increased. Some other questions of local strength might be discussed, but structurally considered, the materials and scantlings at present in use appeared to be sufficient.

Very few Atlantic cargo steamers have sufficient water ballast. From some of the Continental ports considerable quantities of outward cargo can usually still be shipped. From British ports, our somewhat one-sided free trade, together with the McKinley tariff, has so diminished exports to the United States that except to a certain extent by some special lines, there is no outward cargo, or scarcely any, to be carried. It is necessary, therefore, to make the outward passage in ballast, that is to say water ballast. The 500-ft. 12,000 tons deadweight steamer should have not less than 4,000 or 4,500 tons of water ballast, of which 1,700 tons can be carried in the double bottom tanks, 2,000 tons in two "deep tanks," one aft and one forward, at about the quarter length, midway between the engine and boiler space and the stem and stern, and 800 tons in "'tween deck" tanks between the main or upper and first lower decks. The latter are to be preferred for part, if not the whole, of the additional water ballast above that carried in the double bottom tanks, not only in order to raise the center of gravity of the ballast, and so ease the motion of the vessel when rolling, but also because the 'tween deck tanks, if properly designed, reduce broken stowage as compared with the "deep tanks," and are more convenient for loading and discharging than the deep tanks. They should be fitted between transverse bulkheads the full breadth of the 'tween decks. The position of the deep tanks should not be immediately before or abaft the machinery space. If placed immediately before the boiler room, a deep tank will sometimes interfere with convenient bunkering arrangements; and in any case, with the weight of the engines and boilers and of the bunker coals for both the outward and the homeward passage, necessarily concentrated in the middle of the ship, 2,000 tons of additional weight as water ballast cannot be placed in the middle without causing some alteration of form and also causing undesirable strains on the shelter deck and possibly on the engines and shafting. On the other hand, large peak tanks in the extreme ends of the ship are undesirable as promoting pitching, vibrations, and uneasy motions. A large addition might be made to the water ballast carried in the double bottom by carrying the inner bottom straight through to the shell plating at the upper part of the bilges, and he was not aware of any reason why shaft tunnels should not be used for water ballast as had been proposed.

The questions of propelling machinery and speed are not at the present moment very difficult, with an exception that may be referred to further on. Large steamers are more easy and economical to drive than small ones. When they run in a regular line in turn with smaller steamers, it is desirable for them to be fast enough to make up on the voyage for the longer time they take in port to load and discharge than the smaller steamers. In the Atlantic larger power is required than for Eastern trades. It is understood that one at least of the great lines trading to the East is carrying cargo at only 9 knots. With head winds, steamers of similar power to that in the Atlantic would be reduced sometimes to about 6 knots. The A steamer, 11,700 tons deadweight, and B steamer, 11,500 tons deadweight, steam 11 knots average loaded, consuming 45 tons per day of north-country coals; the C steamer, 10,700 tons deadweight, 12 knots, consuming 52 tons per day (those steamers have forced draught but not Serve tubes). The three-cylinder triple-expansion engines, with single-ended boilers working at 180 to 200 lbs. pressure, and Howden's system of forced or Brown's system of induced draught, are economical and durable, and as satisfactory, on the whole, as any other design that has been tried. This statement must be made, subject to further experience of the effect of forced or induced draught on the durability of the boilers. It is largely a question of care and intelligence in working the boilers, but so far, with careful and skilful handling, there is no reason to believe that forced draught boilers need be short-lived.

The point of difficulty referred to is the question of shafting, and particularly of the propeller shafts. It is recorded in "Lloyds' List" that 173 steamships were disabled in 1898, mostly in the Atlantic, through fracture of shafting. It is stated that fifty-three similar accidents occurred in April, May and June this year. This can only be regarded as highly unsatisfactory. The causes usually assigned for these accidents are—the practice of steaming outwards from Europe to American ports in ballast, and generally with very insufficient ballast—the lightness of steel ships, and the reduction of their draught in ballast trim due to their floors and their lower lines forward and aft, having been made so much fuller than formerly. He did not consider these causes entirely sufficient to account for the remarkable increase in the number of shafting casualities that had occurred during the last two years. They undoubtedly have much to do with the trouble, but some of them have been in operation for many years. It may be taken as established that the diameters of shafting, and particularly of propeller shafts, as required by the rules of the Registry Associations and the Board of Trade have been, and are still, insufficient. The Committee of Lloyds' Register have already increased their requirements for propeller shafts about 16 per cent., and it is believed that they have under consideration the necessity of a further increase. Greater attention is being paid to the protection of propeller shafts from corrosion and from sudden diminution of strength at the outer edges of the brass liners. These improvements will tend to diminish shafting casualties, but they will probably not be found sufficient to prevent them. It may be necessary to go back to the practice of having an outer bearing for the tail-end of the shafts, but for reasons for which he need not enter into, he did not recommend it. He should, in large

single-screw vessels for Atlantic service, recommend increasing the strength of the propeller shafts 100 per cent. above the present rules.

There is reason to believe that during the last three or four years not only has the practice of running steamships across the Atlantic in ballast increased, but the captains and engineers, having grown bolder and more accustomed to it, have been less careful to slow their machinery down to half-speed in bad weather when the vessel is pitching and racing badly. With the old compound engines governors were used, and were at least of some use, and in very bad weather the engines had to be slowed or the machinery would have been shaken to pieces. With three-crank triple engines governors are less effective, and are now seldom used, and the main engines are not so severely tried by running through heavy seas as with two cranks. But the propellers and propeller shafts bear practically the same strains with triple engines as with compound. The shafting is smaller in diameter, as compared with the power of the machinery and the size of the ships, than under the old rules for compound engines. The bending strains on the tail-end shafts, when the propellers are only partly immersed and the blade strikes the sea, are as great, if not greater, in new steamers than they used to be in the old compound steamers.

Considering the enormous and incalculable strains brought on the propeller shafts, with the vessel pitching and the engine "racing," there is no reason for surprise that propeller blades and shafting are frequently broken at sea. Unless it be made impossible to run the engines more than half revolutions when in "racing" weather, it may be doubted whether an increase of even 100 per cent. above the present rules would be sufficient to prevent fractures.

For large steamers carrying 10,000 or 12,000 tons of valuable cargo, the ship and cargo being valued at perhaps $1,500,000, duplicate engines and screws should be provided. In addition to the immense advantage of having an additional propeller in the event of one breaking down, the advantage of being able to use smaller screws when running in ballast is very considerable, and in a bad weather passage will often shorten the voyage. It may be taken that twin engines increase the first cost, and usually increase the space occupied, and in fine weather are less efficient by about 5 per cent. Yet these disadvantages, together with, in most cases, a slight increase in the cost of working, are more than outweighted by the increased safety from breakdown and disablement at sea. In ships of about 500 ft. long or more it may be said that twin engines are also necessary for handling the steamers in confined spaces.

It would be interesting to know the experience of other builders, but our own experience has been that the cost of building with the ordinary appliances is considerably greater per ton in very large ships than smaller ships. The cost per ton diminishes as the ship increases in size up to 5,500 or 6,000 tons deadweight, but gradually increases from 6,000 tons deadweight upwards. This increase is partly due to the larger ships being usually built on an improved and less simple specification, but is also largely due to the greater expense of handling the increased weight of frames, beams, and other parts of the vessel, and the increased height to which the weights have to be lifted while building. The expenses of shoring and keeping very heavy ships in shape are also considerably greater, even than in proportion to the increased size of the ships.

The increased cost of handling the materials for big ships finally determined my firm to provide steam or electrical power, not only for hoisting the materials, but for transporting them and placing them in position. In considering the structural arrangements necessary for supporting overhead cranes, the advantages to be gained by protecting the workmen in our uncertain climate from the weather appeared so great, that we determined to provide not only lifting appliances, but a complete shelter over the shipbuilding berths for the larger class of steamers we were building. They now, therefore, have covered-in sheds 500 ft. long, with glass roofs and closed-in sides from about 14 ft. above the ground upwards, over two of the building slips. In each of these two electric traveling cranes are provided on rails running the full length, and with jibs revolving below the cranes, so that any part of the ships building can be reached. One of the shed roofs is also used to support an outside cantilever crane commanding a space of 500 ft. in length by 60 ft. in breadth, on which a third steamer can be built.

It has been found that the work can be carried on much more quickly and economically under those sheds than under the old conditions. It has also been found, contrary to the prophecies that were uttered, that the ships under the sheds are more comfortable to work at than the ships built outside. The temperature under the sheds is higher in winter and lower in summer than outside, and though they are open at the ends and at the bottom, there has been no complaint of draughts. It has also been found that there is, together with a saving in the cost of staging and increased safety, a saving in the cost of shoring and fairing the vessels, as the columns supporting the roofs are freely used as abutments for the shores, which are consequently much lighter and more handy to use than if required to reach from the ground.

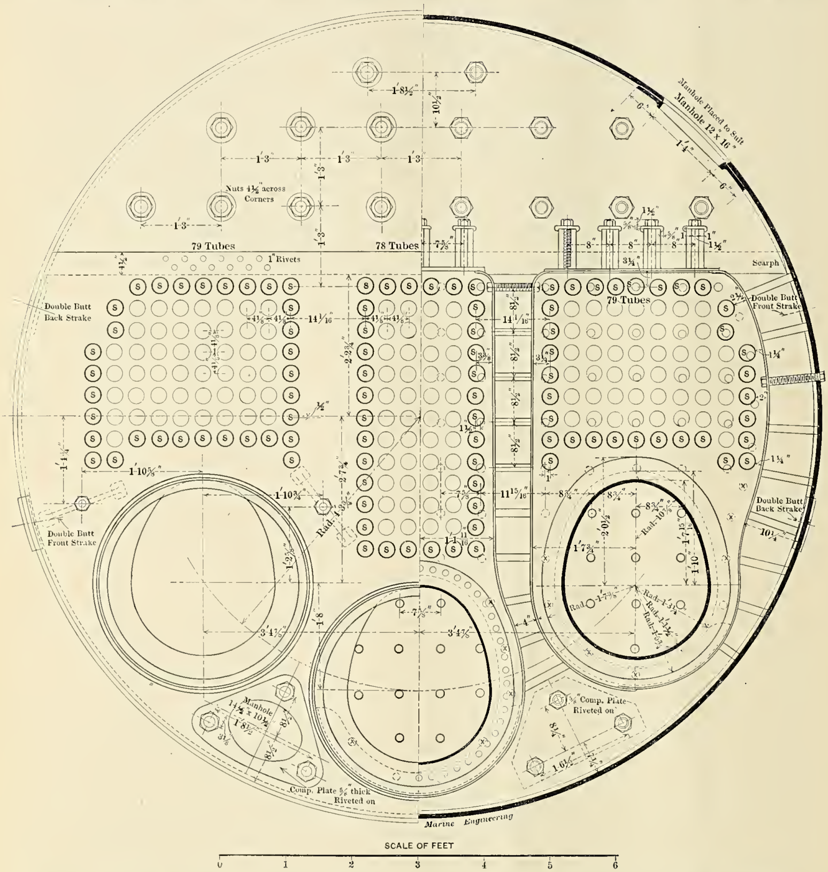
The one disadvantage (which was foreseen) is that although the roof and most of the sides are of glass there is a slight diminution of light, which has to be met with by increased use of electric lighting.

Wireless Telegraphy.—A practical test of the Marconi system of wireless telegraphy, under the supervision of the inventor, William Marconi, will be made during the forthcoming international yacht races at New York. Arrangements have been made by the *New York Herald* by which the races will be reported from the new steamship *Ponce*, of the New York & Porto Rico S. S. Co., and the steamship *La Grande Duchesse*, of the Plant line, both of which will be fitted with the Marconi apparatus. Signor Marconi is now in this country, having come over recently with the necessary instruments and two assistants. Messages will be sent from the ships so fitted to a cable ship, which will be fitted with the receiving instruments and which will be anchored near the Scotland Light Ship. From the cable ship the messages will be transmitted to the city by the submarine and land wires.

The purchase of the late Baron Ferdinand de Rothschild's steam yacht *Rona* by Amzi L. Barber, member of the New York Yacht Club, has been reported.

TYPE OF FIRE TUBE BOILER ADAPTED FOR TUG-BOAT SERVICE.

It is a peculiar fact that in no class of boats is there less progress shown in construction than in tug boats. Of the great number of this style of craft plying in our harbors, rivers and lakes, many of small size, and even some of the large and powerful boats, are still equipped a decided advantage over two cylindrical furnace-flues of small diameter in the Scotch type, and the reduction of diameter of shell allows more room at the sides of the boiler. On the other hand, the water legs are so narrow that they soon become filled with scale, and as it is almost impossible to clean them through the small handholes, it often happens that the leg portions require to be renewed after a few years' service.



WORKING DRAWING OF THREE-FURNACE, SINGLE-ENDED SCOTCH BOILER, WITH INDEPENDENT COMBUSTION CHAMBERS.

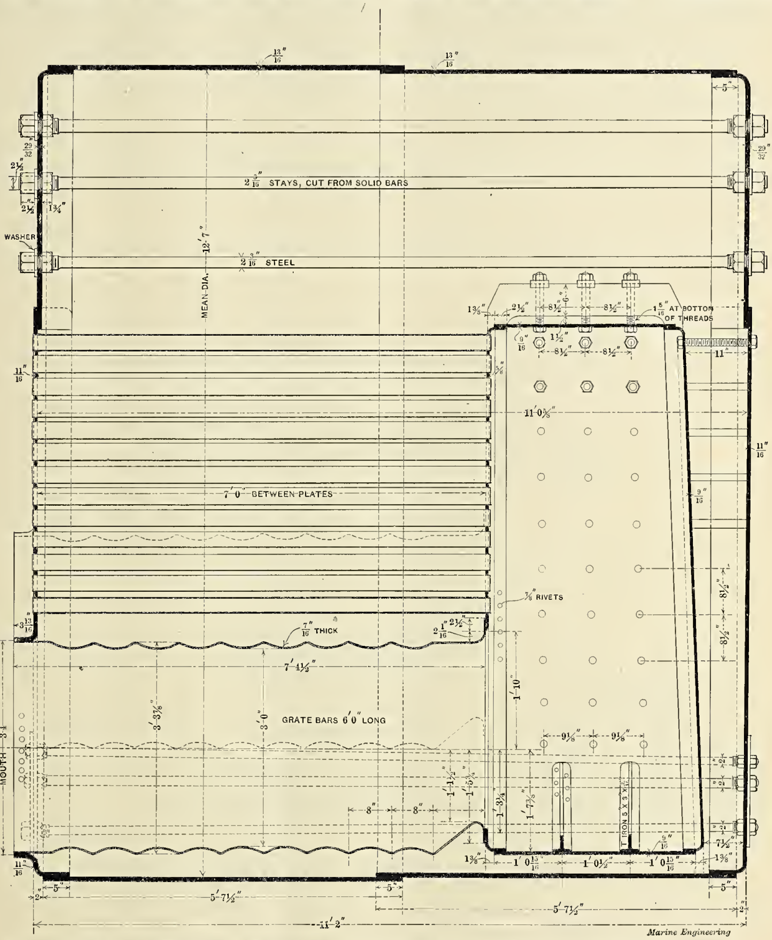
with single cylinder engines and old-style boilers. In latter years the two cylinder compound engine has widely come into use, but the old styles of boilers still remain. By far the greater number of boats use the leg boiler, and occasionally the long cylindrical boiler built up in brick work similar to a factory boiler is used. The leg boiler no doubt has proven to be very serviceable, especially in small outfits having 30 sq. ft. of grate or less, where the high roomy fire-box has

Furthermore, this style of boiler cannot be used for pressures much over 125 lbs., owing to the excessive amount of bracing necessary, which would render it almost impossible to get around inside. The almost universal use of the Scotch boiler in sea-going vessels has demonstrated its capabilities in all kinds of continuous and hard service, and the question is often raised as to the reason why it is not used to a greater extent in tug boat service. Tug boat owners often as-

sert that they would not consider the installation of any other style of boiler than the leg boiler, and give as a reason that leg boilers are cheaper in the long run.

This antipathy can be easily understood on looking over the designs of several so-called Scotch boilers tried in tug boat service. As stated before, the use of small Scotch boilers for this purpose is not good engineering practice, owing to the necessarily small diameter of the furnaces.

In one case which recently came under our notice, the designer had placed two large furnaces in a comparatively small shell, the result being that the furnaces were a considerable distance from the bottom, and the space for the return tubes was very cramped. As a consequence, in order to get a reasonable amount of heating surface the boilers had to be made quite long. With such a large quantity of dead water under the furnaces the boiler could not be worked satisfactorily, and this lack of appreciation of working conditions by the designer caused the condemnation of the type in this particular instance. In another case, a boiler was built with a narrow combustion chamber common to all furnaces, with sides close to the shell, the return tubes being arranged in a solid bank from side to side and extending up to such a height in the boiler as to reduce the volume of steam space and the steam liberating surface to almost one-half of what

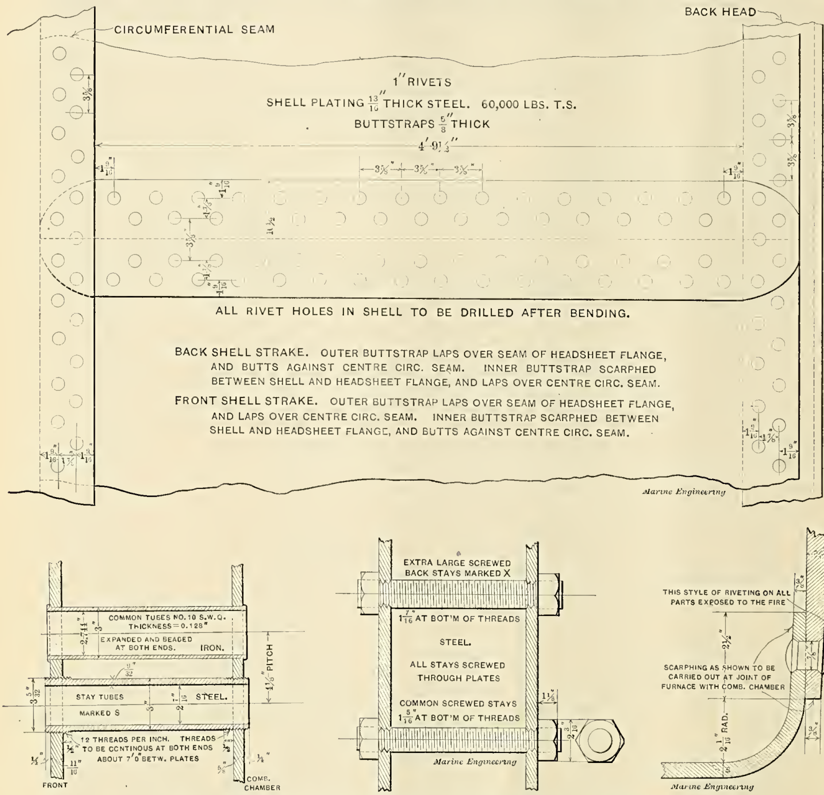


SECTIONAL VIEW OF THREE-FURNACE, SINGLE-ENDED SCOTCH BOILER WITH INDEPENDENT COMBUSTION CHAMBERS.

they should have been. A boiler so designed, while possessing a large amount of heating surface, must of necessity rapidly deteriorate owing to the impossibility of getting at the interior surfaces to clean and scale the boiler. Without going into details of other designs, it can be said that the failure of the Scotch boiler in tug boat service heretofore has been due in almost every case to faulty design.

The building of this style of craft is still greatly a matter of rule of thumb, and the question of first cost is often given undue prominence—from an engineering standpoint—in the considerations which precede the giving of an order by a tug owner. Good designs are like anything else worth having, they cost more than poor or "inexperienced" designs, but probably as long as tug boats are a necessity, so long will there be owners who only consider first cost, and take no proper account of operating expenses and repairs.

With the gradual rise in boiler pressure during the past few years the Scotch boiler is being forced on the attention of tug owners, and taking its place in the better class of tug boat construction, especially in those cases where triple-expansion engines are installed. In the accompanying scale working drawings, a design for a boiler to carry 125 lbs. pressure is shown. This boiler was built some time ago and has seen a good deal of hard service, which it has responded to very adequately, and has been an entirely satisfactory investment for the owner. An examination of the design shows that it has ample heating surface, as well as large steam space, and large steam liberating surface; and this, in combination with the independent combustion chambers, is conducive to steady steaming. Every part of the boiler is easily accessible for cleaning and repairs. The furnaces are of the Morison type, with the Gourly flanged ends, so that they may be easily withdrawn when necessary to renew them without disturbing any other part of the boiler. The whole design is, in fact, based on modern practice for first-class seagoing vessels, and the result, as anticipated, has fully come up to the expectation of the builders. Bituminous coal is the fuel used.



DETAILS OF SINGLE-ENDED SCOTCH BOILER TO CARRY 125 LBS. STEAM PRESSURE.

ELECTRIC vs. STEAM PROPULSION FOR TORPEDO BOATS IN THE LIGHT OF PRESENT PRACTICE.*

BY CHARLES T. CHILD.

The progressive evolution of the modern torpedo boat from the spar and bomb craft of the American civil war has reached its apparent limit along the lines of its more recent development. The steam launch making 7 or 8 knots has grown into the 30-knot seagoing torpedo boat, armed powerfully for offense with automobile torpedoes and carrying a few light guns for defense. To attain the high speed demanded in a torpedo attack, everything has been sacrificed in the design of such boats to the necessity of floating the most powerful machinery in the lightest hull. The results attained challenge admiration when speeds and horse-powers alone are considered, but the craft themselves are adapted to the true tactics of torpedo warfare only in the one particular of speed. When the far more important qualities of silence, invisibility and safety are considered, it is evident that the steam-driven boats enjoy none of them, and that little more can be expected than has already been attained in any of these directions. It is true that the steam turbine seems to hold out possibilities of somewhat higher speeds, but even with the turbine, in boats of small size, it is not likely that any great increase of speed will be made. Of course, if the boat is made larger, higher speeds may be attained, and it does not seem impossible to reach even such a speed as 40 knots with boats of 300 or 400 tons, but the natural question arises as to whether a gain in speed at the expense of secrecy—for the bigger the boat the easier it is to see—is advisable and whether such vessels should have a place in torpedo manœuvres.

The torpedo boat is simply the expression of the principle underlying all strategy—the infliction upon the enemy of a vital blow, costly to him in life and property and terrifying in moral effects, at the least cost in property and life to the attacking party. In other words, a combat between a torpedo boat and fighting ship means that a few men in a little, inexpensive vessel take desperate chances to destroy many men in a large, costly vessel. If the danger of detection and annihilation to torpedo boats be minimized, the value of these vessels will be enormously enhanced. The nation owning a swarm of these wasps of the sea could make its coast safe from attack and erect a barrier of terror that the stoutest sailor would not dare to pass. What chance would a battleship have if simultaneously attacked by five or six boats of, say, 25-knots speed, each armed with automobile torpedoes? It would doubtless sink some torpedo boats, but it would as certainly be destroyed. Assuming, then, that a proper theory of torpedo attack is to risk as little as possible and to make assurance sure by launching a number of boats at once against an enemy so as to divide his fire, it is well to see how the present craft plays its part under such circumstances before discussing the radical innovation which is proposed below.

* From the Journal of the American Society of Naval Engineers.

In the first place, it ought to be said, in justice to the torpedo boats of our navy, which have been maligned by thoughtless critics for what they did and did not do in the recent war, that a torpedo boat is neither a cruiser, a dispatch boat, a yacht, or a coast-guard ship. When highly specialized and necessarily delicate structures such as these are put to work doing duty for which they were never meant, day in and day out, with no base for repairs, no chance to get fresh water and absolutely no fit accommodations for their personnel, it is a matter of wonder and congratulation if all of them are not utterly ruined.

It may be laid down as an axiom that a boat built for torpedo service has to be so specialized as to be unfit for any other duty. The requirements are speed, silence, invisibility, quickness in manœuvre, and the smallest possible crew. A seagoing, cruising torpedo boat is a sort of anomalous contrivance, developed out of the struggle for speeds, and is not, properly speaking, a torpedo boat at all. It is not expected to make torpedo attacks on the high seas. They are directed at blockading vessels, ships lying in a harbor, and in general, at vessels near shore and not going at full speed.

For the boats to be invisible they must be small. In the case of steamboats the visibility is heightened by the smoke and the stacks, while the chances of flaming funnels under forced draft are very good. These convert a torpedo attack into a sort of marine torchlight procession, considerably more dangerous to the attacking party than to the attacked.

Silence is simply an impossibility with a steam craft. The engines will rack and jar, the fans will purr, and the steam, lashed up under the excitement of an attack, will probably blow off.

From all these considerations, then, it is seen that steam torpedo boats making an attack at night (it is needless to say that a torpedo attack in daylight is suicidal folly) will have to run the gauntlet of no less than four dangers of their own making. The enemy is keeping a vigilant lookout and sweeping the waters with his searchlights. The boats must slip into their striking distance—a few hundred yards—without discovery. Suddenly a shower of sparks from a funnel, a hiss of high pressure steam blowing off, a roar of fans and light engines running at furious speeds proclaim the presence of boats and the location of one of them. That one, at least, is apt to be immediately destroyed.

Seeing, then, that the steam-propelled boat has certain vital defects, is it not possible to imagine a vessel free from the dangers that beset the present-day torpedo boat? Cannot another motive power, simple in its application, powerful and silent and controllable, take the place of the snarl of water-filled tubes, the furnaces fanned to destructive heats, the complex engines with their multitude of reciprocating parts flying at fearful speeds under the impulse of high-pressure steam, the ghastly infernos of the fire-rooms, where suffocating men run risks of a dozen kinds of death even in a peaceful cruise? The purpose of this brief sketch is to show that this can be done with that certainty of success that should warrant the attempt.

Let it be assumed that a boat of moderate size has its boilers, coal and engines replaced by accumulators

and electric motors. It is perfectly evident that if such a boat can show the speed of the steamboat, it is superior to it in all the essentials of silence, invisibility and manœuvring power described above, as well as in a smaller crew required and the consequent smaller risk of life in an attack.

To illustrate the present possibilities and limitations of such an application of electric power it is easiest to take a concrete case and show what results can be obtained with the motor equipment.

A boat about 140 ft. long, having a beam of 14 ft. and a draught of 5 ft., will displace, light, 110 tons, and carry normally 30 tons of coal. If 45 tons is allowed for the weight of the hull, ammunition, crew, stores, etc., there is left 95 tons, or 213,000 pounds, for the electrical equipment.

To attain a speed of 22 knots about 1,500 horse power will be required. As the torpedo boat goes at full speed only at the instant of the attack, the motors installed should be such as to work economically at lower speeds, should weigh as little as possible, and should be worked up to their utmost maximum of output for the rush of attack. Without going at length into questions of motor design, it may be said that four motors, each developing 400 horse power at its maximum, are indicated. These, by careful design, using laminated iron in the fields, may be reduced to a weight of 6,500 pounds each, or 26,000 pounds for the four. This leaves 187,000 pounds for the battery, circuits and controller or switching devices. Allowing 12,000 pounds for these latter, and 175,000 pounds for the battery, what performance can be expected of the boat?

In a concourse of automobile vehicles held in France during the past summer, a number of types of light and very powerful accumulators were brought out and given a hard, practical service test by a commission appointed for that purpose. Taking the figures given by them for the performance of the average cell, the 175,000 pounds of accumulators will maintain an output at the screws, the losses in conductors and motors being included, of about 140 horse power for twenty-four hours; 300 horse power for ten hours; 520 horse power for five hours, and 2,000 horse power for one hour—a power that would give a rush speed of as much as 25 knots. At the twenty-four hour discharge rate the speed would be about 9 knots and the cruising radius about 216 nautical miles.

From these figures it is perfectly evident that this craft is fitted to discharge the normal functions of a torpedo boat with entire satisfaction. It has sufficient range at slow speed to travel to some distance from its base. It has a rush speed equal to or greater than that of a steam-driven vessel of the same size. But, above and beyond all this, it has silence, secrecy of movement, absolutely instantaneous and certain control, and other points of advantage so great as to far outweigh the disadvantage of a short radius of action. A comparison of the operative efficiency of the two types, steam and electric, may be interesting.

A steam vessel of this class would carry two officers and about eighteen enlisted men, a total of twenty lives. The electric boat would need only enough men to launch the torpedoes, one officer and five men at the outside. The cost of the boat would be about the same with either system of propulsion. From this it is seen that the risk of property in an attack is the same in the two cases, while the risk of life with the electric boat is far less, the destructive and offensive powers of the electric craft being the same or greater.

It will be at once conceded that a boat without stacks, without smoke, without possibility of a flaming funnel is less visible and less apt to attract the attention of the attacked ship than one of the ordinary type. In the matter of silence there is no high-pressure steam on the electric boat, no boiler tubes to burst and vomit up a small volcano of ashes and fire and steam through the stack, no fans that cannot be stopped during an attack (these would be ventilating fans, of course), no racketing reciprocating engines penned up in a sheet-steel sounding box. It slips through the water in silence and darkness, its low freeboard having no other projections than the conning tower and signal mast.

In the conning tower, or whatever corresponds to a conning tower on a torpedo boat, is the steering wheel and a "controller" precisely similar to those on electric street-car platforms, though somewhat larger. With the handle of this in one hand and the steering wheel in the other the officer in charge of the electric boat has the whole craft absolutely bridled. Every other man aboard may be put out of action and yet a successful run made. There is no transmission of orders—no excited shouting in the noise and steam and sweat of a reeking engine-room—but only the instant and silent answer of the motors to the touch of the controller handle.

The storage battery and motors, both being intrinsically heavy, can be stowed in very small space, well below the water line, and a thin deck worked over the whole. The entire upper works of the boat might be shot away without putting it *hors de combat.* A single well-directed shot, unless it sunk the boat, could do no vital harm, because there is nothing to harm. Both battery and motors, being perfectly divisible, may be placed in numerous compartments, and the electric boat thus so divided that its chance of surviving injury would be greatly increased. The circuits are run in duplicate or triplicate. There are four or five controllers in different parts of the boat, and among the four motors one would always be left in service. A shot from an ordinary small rapid-fire or machine gun would not damage the motors, and if it wrecked a few cells of the battery they could be "bridged across" in a few seconds. Indeed, by using many small cells in parallel groups, the battery could be made to do its work even if well riddled with small shot.

To discharge these batteries would take, ordinarily, four hours. In an emergency it might be done in one hour. They should be arranged to work at the standard pressure of the lighting and power circuits on the large naval vessels—80 volts—so that a boat could be charged from any full-powered ship. This could be done even in a heavy sea, as there would be no occasion for close approach, such as is required in receiving coal or water from the ship. A cable, which might be of any convenient length, would be the sole connecting bond between the vessels.

It has been shown that an electric boat risks fewer lives in an attack, has advantages of silence, invisibility

and manœuvring power, is less vulnerable and incomparably superior to a steam torpedo boat. The only advantage the latter can claim is cruising radius. Is this an advantage? There would never be any suggestions of using the electric boat as a dispatch boat or as anything but a torpedo boat. It is instantly ready for service. Once charged it can speed up to its highest velocity in a few seconds. It can be towed behind any steam vessel to the neighborhood of the enemy, and, once there, can work devastation impossible to any boat handicapped by the danger of being discovered and shot to pieces before it can discharge its torpedo.

This very rough sketch of the present possibilities of the electric torpedo boats is not offered as a solution of the difficult problems involved in their design. It has been written with the hope that it may provoke discussion in which the apparent importance and value of this method of driving may be well ventilated.

U. S. S. Alabama.—The preliminary builder's trial of the U. S. battleship *Alabama,* constructed by the Cramps, was held last month, and a statement was given out that she maintained an average speed in excess of 17 knots. The vessel is incomplete, as the side armor of Harveyized nickel steel is not yet in place. The *Alabama* is a sea-going coast line battleship fitted with two 13 in. barbette turrets, and armed with four 13 in. breech-loaders, fourteen 6 in. rapid fire guns, sixteen 6-pounder and six 1-pounder rapid fire guns, four Colt automatic guns and two 3 in. field cannon. She has also four torpedo tubes. Her dimensions are: Length on load water line, 368 ft.; beam, extreme, 72 ft. 2 1-2 in.; mean draught, 23 ft. 6 in.; displacement, 11,525 tons. Her estimated sea speed when completed is 16 knots. She is fitted with triple expansion engines of 10,000 I. H. P. and Scotch boilers. The *Alabama* was authorized by Act of Congress passed in June, 1896, which also called into being the battleship *Illinois,* building at Newport News, Va., and the battleship *Wisconsin,* building at the Union Iron Works, San Francisco. The *Alabama* is practically ready for service, with the important exception of her armor, the delay in completing her being caused by the armor plate dispute.

Rammed an Iceberg.—When the Anchor Line steamship *City of Rome* arrived at New York from Glasgow early last month she reported having been in collision with an iceberg in mid-ocean. The weather was very foggy at the time, and Captain Young was going dead slow when the iceberg was sighted a short distance ahead. The engines were sent full speed astern and consequently the vessel had very little way on her when she struck the iceberg. She slid up on a submerged portion of the berg and remained an instant or more in this position, until she slid off again and backed away. An examination showed that no serious damage had been sustained. The passengers were at dinner at the time, and for awhile there was considerable excitement. The officers and crew, however, behaved with such coolness and promptness in taking emergency measures that quiet was speedily restored, and when the safety of the ship had been ascertained the voyage was resumed without further incident.

LIMITATIONS TO THE APPLICATION OF ELECTRICAL PROPULSION TO TORPEDO BOATS.*

BY WILLIAM F. DURAND, MEMBER.

The application of electricity to marine propulsion has in recent years attracted the attention both of electrical and marine engineers, and the successful operation of the electric launches at the World's Columbian Exposition in 1893 gave to many strong hopes that the field of such application might be immediately widened to include small craft of all descriptions and for all purposes, and that the day was not far distant when even large craft as well—the liner, the freight steamer and the warship—would all derive their propulsive power from energy stored in the electric form. It was early recognized, however, that energy embodied in storage batteries is excessively expensive in weight as compared with energy embodied in coal, and furthermore that electric motors are usually heavier for the same power than the lightest types of steam engines. These facts introduced a prompt limitation to the extension of electric propulsion, especially to cases where high speed or long endurance was desired.

In a paper published several years ago the author showed the limitations and presented the possibilities of electric propulsion as given by the practice of that day. It may not be without interest to reconsider the same subject briefly, and to note what advances have been made since the publication of that paper. Especially may this be suitable at the present time in connection with the appearance of an article by C. T. Child† on the same subject.

The data which are used in the latter article and which are made the basis of the case as presented, seem to be considerably beyond current American practice, and undue expectations may perhaps be awakened regarding the readiness with which such results could be realized.

In regard to the fundamental values assumed for the torpedo-boat, it may be said that the power is perhaps a trifle low for the displacement and speed, and the fraction of weight available for machinery and propulsive equipment rather high, both tending, of course, to make a better case for the electrical equipment. These differences, however, are not of particular importance, for the question of the availability or otherwise of an electrical equipment rests on considerations of a more serious and fundamental character.

Let us then proceed to a comparison between an electrical and a steam propulsive equipment, using, in addition to the data taken by Mr. Child, such additional safe values from modern engineering practice as might naturally be made the basis of a business contract. We need first to specify units of *power* and *work* relative to which the comparison may be made. For these we shall take respectively the *horse power* delivered to the screw shaft, and the *horse power per hour* delivered to the screw shaft.

For the steam equipment we may allow 2.5 lb. coal per horse power per hour on the shaft. This will occupy about .05 cu. ft. bunker space. For the total weight

*From the Journal of The American Society of Naval Engineers, Washington, D. C.

† See page 151 of this issue.

of steam equipment, including engines, boiler and auxiliaries, all in steaming condition, we have values ranging from 40 lb. to 70 lb. per power unit on the shaft. Of this amount the engine-room weights furnish rather less than one-half and the boiler-room weights rather more than one-half.

Turning now to the electrical equipment, we must examine the weights of batteries and motor for the same units on the shaft. Taking first the batteries, we must distinguish two questions: (1) How much battery is necessary in order to actually attain a certain desired power, aside from the question of endurance? (2) How much battery is necessary in order to embody a given amount of energy, aside from the question of how rapidly it is used or how much power is developed? The two questions are not independent, and must be examined together.

In Fig. 1, *A B* shows the nature of the relation between the total capacity of a storage battery and the time of discharge, while *A C* shows the corresponding value of the discharge current. Beyond 3 or 4 hours the

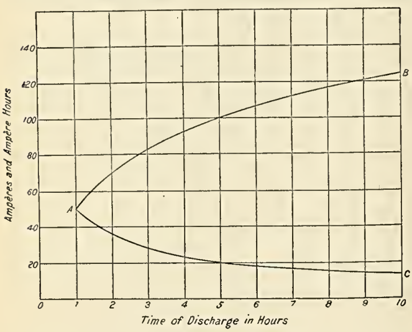


FIG. 1

Capacity in ampère-hours and corresponding current in ampères for varying time of discharge. For relative purposes the capacity at five-hours' discharge is taken at 10 ampère-hours.

total capacity more slowly increases with the time, as shown, while for a shorter period the total amount which can safely be taken from the cells quite rapidly falls off. The power which can be developed depends, then, simply on how rapidly the cells can be discharged, and is, of course, proportional to the discharge current, as shown by *A C*. The limit to the development of large power from a small battery is, therefore, the increasing danger of damage to the cells resulting from excessive rates of discharge, and the rapidly decreasing time during which the power is available. The normal discharge period is usually taken at from 8 to 10 hours, but with care it may, with the best types of cells, be safely decreased to 4 or 5 hours. For a few moments the discharge current may even be increased far beyond the values corresponding to these periods, but for what may be termed continuous conditions a rate corresponding to discharge in 4 or 5 hours is about the maximum usually employed.

If we take now the weights of the leading American storage cells as built for stationary purposes, and derive for the various rates of discharge the weight per *horse power per hour* of battery output, and of weight per *horse power* of output, we shall find values as represented by *A B*, Figs. 2 and 3, respectively. The increase of weight per work unit as well as the decrease of weight per power unit, as the time of discharge is decreased, are both clearly shown by the diagram. In

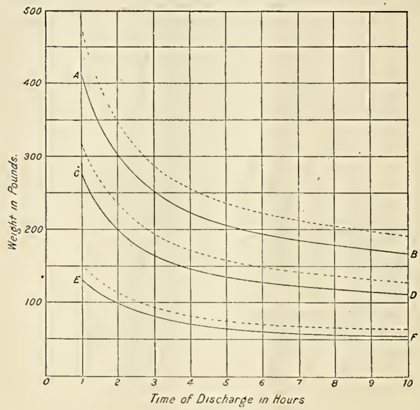


FIG. 2

Weight of batteries per H. P. per hour for varying time of discharge

these cells the weight of the lead elements is from 50 to 55 per cent. of the cell complete with acid and lead-lined wooden tank. In a somewhat lighter form of construction for cells of the same type the weight of the lead elements is about 65 per cent. of the cell complete, and the latter ranges at about two-thirds of the values shown

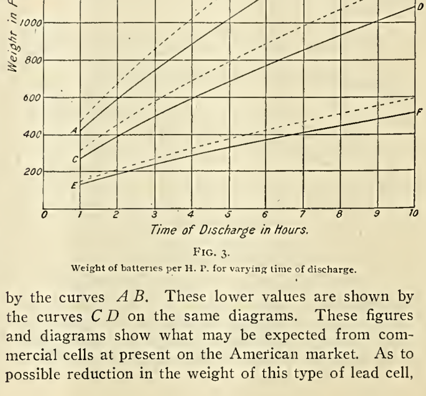


FIG. 3.

Weight of batteries per H. P. for varying time of discharge.

by the curves *A B*. These lower values are shown by the curves *C D* on the same diagrams. These figures and diagrams show what may be expected from commercial cells at present on the American market. As to possible reduction in the weight of this type of lead cell,

the future alone can determine. It is a significant fact, however, that these cells as built at the present day, are considerably heavier than those on the market a few years ago. This seems to indicate that for purposes of durability, reliability and continuity of operation, the heavier type of construction is preferred where the additional weight is not a special disadvantage.

Turning now to the results given by the report of the French tests of automobiles, as referred to by Mr. Child, we find an entirely different range of figures. In these cells the normal period of discharge is taken as 5 hours, and the figures for power output and capacity refer fundamentally to this period. At the same time the capacities for a discharge current double and half the normal value are also stated. These correspond to periods of about 2 and 11 hours. Between these limits the resultant capacity curve plotted on time agrees fairly well with similar data derived from American practice, and the curve AB of Fig. 1, which represents a series of mean values drawn from a considerable range of recent American data, may probably be taken as representing satisfactorily the relative capacity curve for the automobile battery as well.

In this battery the weight of the lead plates is about 70 per cent. of the cell complete. For the latter, the weight per horse-power output for a 5-hour discharge is 321 lb., and per horse power per hour output 64 lb. It will be seen that these figures are from about one-half to one-third those for the cells on the American market. They are represented by the curves EF in Figs. 2 and 3. As to how far it would be safe to expect that this lighter type of construction would be suitable for marine propulsion, it is difficult, from the description given, to form a satisfactory opinion. Until more evidence is forthcoming, however, their suitability to such uses may be fairly open to some doubt.

With regard to the space occupied, and basing the total output on the 5-hour discharge, we find for the American cells a space of from 1 to 1.4 cu. ft. per horse power per hour output, while for the lighter automobile cells the space required is about .5 cu. ft., or about in the same proportion for space occupied as for weight.

It will be noted that the above figures for batteries all refer to output. Assuming a motor efficiency of .87, we may reduce to similar units on the shaft by dividing by this ratio, an operation which will increase the several figures by about 15 per cent. of their former values. A uniform efficiency as high as .87 is more than can be expected, especially for the extreme conditions, but the error favors the electrical equipment, tends toward simplicity of treatment, and is not significant for the purpose in view, which is not so much to take account of all secondary influences as to show the general character of the results to be expected under the various suppositions made. In Figs. 2 and 3 the increased weights are shown by the dotted lines. For the space occupied the figures will be from 1.15 to 1.60 cu. ft. per horse power per hour for American batteries, and about .58 cu. ft. for the automobile battery.

Turning now to the motors, we find a wide variation in figures. During the past five years some advance has been made in the reduction of weights, and, taking values representing the best actual practice, we find from 30 to 50 lb. and upward per horse power on the shaft. The minimum figures correspond to revolutions per minute of not over 400 or 500 for the larger sizes. Some further saving might still be made by an increase of revolutions, but such saving is limited, for the weight of motors by no means decreases as the revolutions increase. Heating in the armature and poles, and structural considerations connected with the necessary space for insulation, etc., place an early limit on the reduction of weight by increase of revolutions. As suggested by Mr. Child, also, some further reduction might be made by more extended use of laminated iron in the field, but it may be fairly questioned whether so large a reduction as that implied in the figures given in his article could be hoped for. In any event, so far as the author is aware, motors weighing only 16 lb. per unit of horse power output are not the subject of current design; they are not on the market, and it is doubtful if reliable builders would care to guarantee weights much below the minimum stated above. If we take the best of present-day practice, as represented by motors actually built and ready for use, we shall not be able to go much below 30 lb. per horse power on the shaft for such motors as would be suitable for purposes of marine propulsion. We will, however, assume 25 lb. as presumably obtainable at the present time by special design.

Taking the figures given above, it results that for equal amounts of work delivered to the shaft, storage batteries, on the basis of a 5-hour discharge, weigh from thirty to nearly one hundred times as much as coal, and occupy from ten to thirty times as much space. For the same power delivered to the shaft, the electric motor will weigh somewhere about one-half the total weight for a steam boiler and engine, and rather more than the engine-room equipment alone.

It is quite evident that in an electrical equipment the weight of battery will be the chief item, and that the necessary weight will be determined by the maximum power required and by the safe rate of discharge at which this power may be developed.

If the maximum speed of the boat is to be considered as 22 or 25 knots, then in order that such a term may have any significance in a tactical or naval sense, it should be possible to maintain this speed for at least one hour, and, preferably, more; and it would seem unwise to use in the development of such a speed, for a period of an hour or more, a discharge current higher than that corresponding to a 4-hour complete discharge. It is true that a boat thus equipped could make rushes of short duration at a much higher rate of speed, but to be of tactical value their safe duration should extend beyond periods of a few minutes. It may be here noted that in the report of the French Commission on automobiles, the maximum discharge considered as allowable for anything beyond momentary rushes of current is that corresponding to complete discharge in about 3 1-4 hours, a current one-third above the normal for a 5-hour discharge. A further limitation arises from the rapid loss of safe total output at excessive rates of discharge, so that the relative endurance rapidly decreases as the discharge current is increased.

Thus, according to the law indicated in Fig. 1, a doubling of the discharge rate for a 4-hour period will reduce the endurance to one-fourth its value, or to about one hour. The qualities of a torpedo-boat and the conditions which she should fulfill are, of course, largely matters of opinion; but taking into consideration ques-

tions of tactics and safe endurance, it would seem as though a requirement of full speed for one hour at a discharge rate not exceeding that for a 4-hour endurance, or a possibility of full speed for 4 hours, is little enough to require of a boat intended to meet the probable exigencies which may attend the operation of such craft. Taking the values from Fig. 3 for a 4-hour discharge, we find that for a 140-ton boat, with 2,000 shaft horse power, the weights required would be, for American batteries, from 1,400,000 to 2,000,000 lb. in round figures, and for the automobile battery about 650,000 lb. In any case the weight required is several times the total displacement of the boat, and hence entirely out of the question. For 1,500 horse power the weights would be three-fourths of the above amounts, and hence equally unattainable.

It is thus clear that the requirements as laid down, and as they might naturally be taken, having in view the results attained by steam equipment, are entirely out of the question. Even in the case of the automobile battery, regarding the suitability of which we may still reasonably doubt, the weight required for batteries alone is about twice the total displacement of boat. We may then naturally, as does Mr. Child, approach the question from another standpoint, and, taking a certain amount as disposable for motor and batteries, investigate the possibilities.

To this end let us assume that the motors are to be rated normally for the power which would be developed with the 2-hour discharge current. They could then stand, for short periods, increased rates of discharge up to that corresponding to a 1-hour endurance. This would provide for the possibility of short rushes at excessive rates of discharge and developed power, and the motors would, of course, be more than ample for lower rates and longer periods of endurance. For a 2-hour discharge current, according to Fig. 3, American batteries will weigh from 440 to 660 lb. per horse power on the shaft, and the automobile battery about 210. Adding say 25 lb. for motor, we should have respectively the figures 465 to 685, and 235.

Out of the total displacement of 140 tons we will take, for our present purpose, the same amount as that assumed by Mr. Child, viz.: 201,000, as disposable for motors and battery. Dividing this weight by the above figures, we should find for the rated motor powers, respectively, 293 to about 430, and about 850. The corresponding motor weights would be, respectively, 7,325 to 10,750 and 21,250. The balance available for battery would be, respectively, in round numbers, 194,000 to 190,000 and 180,000, and on the basis of the laws expressed in Figs. 1 and 3 we might expect results somewhat as given in the following table (next column):

A boat with capacities as given by these figures may be made use of in a variety of ways, but even in the most favorable case such a craft is not a torpedo-boat. So far as the use of the results from the report of the French Commission on automobiles is concerned, the chief difference between these figures and those derived by Mr. Child is in the possibilities at excessive discharge rates. Experimental information on this point does not seem to be given in the report. The normal rate of discharge was considered to be that for a 5-hour period, for which the figures as taken from the report have been given here. In addition, statements were made regarding the capacities at double and half the normal rates of discharge, as previously noted. In the actual tests as shown by the time of run and by the graphic logs of the discharge currents, the mean rate was only slightly above the normal, though momentarily it rose to values two or three times as great. The general law connecting safe capacity with the time of discharge, as shown

Time of Complete Disch'rgé	Heavier American Battery.			Lighter American Battery			Automobile Battery.		
	Power.	Speed.	Endurance.	Power.	Speed.	Endurance.	Power.	Speed.	Endurance
1..........	412	15.2	15.2	618	17.2	17.2	1,320	21.0	21
2	290	13.6	27.2	435	15.5	31.0	929	19.5	39
3..........	2 8	12.7	38.1	342	14.4	43.2	730	18.0	54
4	190	12.0	48.0	285	13.5	54.0	609	17.0	68
5..........	164	11.4	57.0	246	12.9	64.5	525	16.4	82
10..........	103	9.9	99.0	155	11.2	112.0	330	14.1	141
24	52	8.0	192.0	78	9.0	216.0	167	11.5	276

in Fig. 1, and particularly for very small periods, has been already referred to; and extending such general law to the lighter automobile cell, it follows that the expectation of 2,000 horse power for 1 hour, based on the actual performance of about 500 for 5 hours, is far beyond what is likely to be realized. This would require a safe capacity for one hour of about 80 per cent of that for 5 hours, an assumption requiring the same general rate of decrease between 5 hours and 1 hour as is usually found between 8 or 10 hours and 5 hours. Available data shows that this expectation is far from any probable realization.

Even if the automobile battery were found well suited to marine propulsion and the full results as derived by Mr. Child were obtainable, the resulting boat would be of problematical value, for the utility of a torpedo-boat with an endurance of only 25 miles at full speed may fairly be called in question. What should we think of a like torpedo-boat with steam equipment developing 2,000 horse power, and carrying only about 2 tons of coal instead of 20 or 30 tons?

Let us now turn briefly to the possibilities under steam equipment with the same weights available for propulsive purposes. Taking the total weight of 213,000 lb., as assumed by Mr. Child for motors, batteries and controlling devices, we will first assume 30 tons of coal. This leaves 145,800 lb. available for steam machinery. Without going to the extremes of light construction, this would provide for the development of from 2,500 to 3,000 I. H. P., giving from 2,200 to 2,700 horse power on the shaft. Taking again only 10 tons of coal as corresponding to trial conditions, we should have 190,600 lb. available for steam machinery, which would provide for the development of from 3,000 to 3,800 I. H. P., giving from 2,700 to 3,400 horse power on the shaft. These figures correspond closely to the latest Navy Department designs for torpedo-boats, where, with 150 tons displacement, 3,000 I. H. P. are to be developed on 178,600 lb., giving practically 60 lb. per I. H. P. Merely as a matter of comparison with the electrical equipment it would not be unfair to reduce the coal to the amount necessary for 1 hour at full speed. If short endurance is admissible in

one type of boat it should not be denied the other. This would reduce the coal to about 4 tons, leaving 204,040 lb. for steam machinery, on which from 3,400 to 4,000 I. H. P. could be developed, giving from 3,000 to 3,600 horse power on the shaft. Of course no one would think seriously of a boat with so small a coal supply, but for comparative purposes it serves to show how wide is still the gap between the possibilities with steam and electrical equipment. With the former we readily develop three times the power possible with the latter, even under the best conditions furnished by the automobile batteries, and from six to eight times the amount under the best conditions given by the standard batteries on the American market. On this point it should be said that these batteries are intended for stationary use, and are not designed or built with a particular view to the saving of weight. With the latter point in view, doubtless a lighter type of construction could be developed, and the figures for the French automobile battery reproduced. The durability and adaptability to marine propulsion of such a battery would still be an open question, and only to be settled by the appeal to experience. All this, however, as we have seen above, would still leave the electrically driven torpedo-boat far from a reality.

The subject of cost should also be noted in connection with the general comparison between these two modes of torpedo-boat propulsive equipment. Mr. Child makes the statement that the cost would be about the same in either case. It is hard to find prices which verify this statement. Steam machinery complete may be built for from $20 to $25 per indicated horse power, or from say $22 to $27 per shaft horse power. The electric motors, including switches, controlling devices, etc., will very nearly cover these figures, leaving the first cost of the batteries practically without an offset in the steam equipment.

Recent net quotations on American storage batteries were on the basis of about $9 per 100 ampere hours for a 5-hour discharge. In large quantities we might expect a reduction, but probably not below from $6 to $7 for the same unit. This would correspond to from $24 to $28 per horse power hour on the shaft or from $120 to $140 per horse power on the shaft for the 5-hour discharge. Taking for commercial American cells the possibilities in the present case at about 200 horse power for 5 hours or 1,000 horse power hours, we should have for battery alone say $25,000. Taking the motor as rated at 350 horse power, its cost would be, perhaps, about $7,000, thus giving $32,000 for the electrical equipment. A 350-horse-power steam equipment complete could be provided for from $8,000 to $10,000.

Regarding the cost of energy in storage batteries, it appears that, taking into account the losses incident upon the various transformations through which it is passed, that mechanical energy delivered to the shaft by a motor from a storage battery will cost nearly twice as much in pounds of coal at the steam engine which charges the cells, as it would if delivered direct from the engine to the shaft. That is, for equal amounts of work on the shaft, electrical propulsion will require the initial consumption of nearly twice as much coal as with the steam engine coupled direct to the screw shaft, the two engines concerned being of about equal efficiency.

There are still other questions which may affect the application of electricity to torpedo-boat propulsion, such for example as the need of protecting both cells and motors from salt water, the need of closing in the cells so as to prevent spilling of the acid due to rolling, questions of durability, repairs and renewals, questions relating to the dependence of a boat upon a generating set as a base of supplies for recharging the cells, etc. These are, however, of secondary importance in comparison with the fundamental question of what can be done, granting that all secondary questions are supposed to be favorably answered. The present paper is concerned with this fundamental question rather than with those of secondary importance. All special discussion of torpedo-boat tactics or of the special suitability or otherwise of limited endurance to torpedo-boat service have been also left aside as unnecessary to the main purpose of the paper.

There are, of course, many special advantages connected with electrical propulsion, such as relative noiselessness and freedom from vibration, absence of smoke or flame, safety from disastrous explosion, instantaneous readiness for use so long as charged, etc., and it is to be most strongly regretted that the limitations are of such a character as to render the possibility of availing ourselves of these features dependent upon a reduction in the weight of storage cells which at present seems hopelessly beyond reasonable expectation. When it is realized that the light French automobile cell weighs some three hundred times as much as coal for equal energy stored and some thirty times as much for equal amounts of work at the shaft, it is clearly apparent that so long as these relations hold the storage cell cannot hope to displace coal for marine propulsion, except in those cases where moderate speed and short endurance are not objectionable. To our present-day judgment it would seem that if energy stored in the electrical form is to rival in compactness that stored in coal, it will require a development along some line entirely different from that represented by present-day storage cells.

What developments in these lines the future may hold for us the event alone can determine, and should the day soon come when electricity can be satisfactorily and efficiently employed for the attainment of the highest results in marine propulsion, probably none will be more ready to welcome the change than those who see in its present-day limitations an insuperable bar to its use at the present time.

Alexander Stephen, senior member of the shipbuilding firm of Alexander Stephen & Sons, on the Clyde, died recently, aged 67 years. The Stephen family has long been identified with the industry of shipbuilding in Scotland, the deceased having followed it all his life, learning the practical side of the business in his father's yard. To Mr. Stephen is given the credit for the introduction of the composite system of building ships. Many of the vessels built under his direction performed notable service, the best known on this side perhaps being the Confederate cruiser *Shenandoah*, which previously had been a merchant vessel. The yard got a good deal of unenviable notoriety a number of years ago, due to the overturning of the steamer *Daphne* when she was launched, which resulted in the drowning of a great number of workmen and others who were on the vessel at the time.

PROGRESS OF THE PARSONS STEAM TURBINE FOR MARINE PROPULSION.

In former issues we published a considerable amount of data concerning the Hon. Charles A. Parsons' experimental vessel *Turbinia*, which was in the form of papers read by the inventor before British technical societies. Since the reading of those papers and the consequent world wide announcement of the success of the turbine driven experimental 100 ft. boat, much work has been done by the inventor in the direction of extending the application of the turbine to marine propulsion. A company styled the Parsons Marine Steam Turbine Company was formed late in 1897 for the purpose of taking over the rights and property of the original organization which built and tested the *Turbinia*. The new company, started with a capital stock of $1,250,000, was organized for the purpose of placing the invention on a commercial basis and entering into actual competitive practical work on a large scale. A site containing about 23 acres of land was secured at Wallsend, on the river Tyne, on the northeast coast of England. Suitable machinery for the construction of the turbine engines was purchased, and an extensive use was made of electric motors for power purposes, the generators supplying current being driven by turbines.

The company has now in hand two torpedo boat destroyers of large power and high speed, one, we understand, being for the British Government, and the other for Armstrong, Whitworth & Co. One, if not both, of the vessels is fitted with two separate sets of engines for the port and starboard sides respectively, and four propeller shafts. One each side the outer shaft is driven by a high pressure turbine, and the inner by a low pressure turbine, the inner shaft having also a small reversing turbine connected up. The total power available for going ahead is 10,000 I. H. P., which, on the dimensions, is calculated to give a speed of 35 knots. There is enough power available for reversing to send the boat astern at 16 knots. Condensers are fitted for each set of engines, and the air pumps are driven by small turbines, so that all reciprocating parts are got rid of, together with the probability of annoying vibrations which the usual form of pump would set up. For boiler feed steam pumps of the Weir pattern are fitted. Lubrication of the main bearings is secured by a system of forced oil circulation.

To get this amount of propulsive power upon the displacement of the regular 30 knot destroyer means, of course, a saving of weight somewhere, and in this is pointed out one of the advantages of the turbine method of propulsion. The engines are of less weight though of vastly more power than reciprocating destroyer-engines, and the saving here is made use of in the needed enlargement of the boiler capacity. This amounts to about 12 per cent in size. A gain is also expected in the steam consumption of the turbines as compared with the most economical form of the reciprocating type of engine. There is also a saving in weights of shafting and propellers. In a destroyer of 310 tons displacement it is estimated closely that the saving in machinery weights will permit of an increase of the steam raising capacity to the extent of about 2,000 sq. ft. of boiler heating surface. It is also claimed by the inventor that on account of the absence of heavy reciprocating parts, linkage, etc., in the engines that they can be made with a larger margin of strength and capacity than reciprocating engines.

A comparative statement is made between a destroyer of 320 tons displacement equipped with express water tube boilers and turbine engines of about 12,000 I. H. P. and a destroyer of say 300 tons displacement with express water tube boilers and reciprocating engines of about 6,000 I. H. P., as follows:

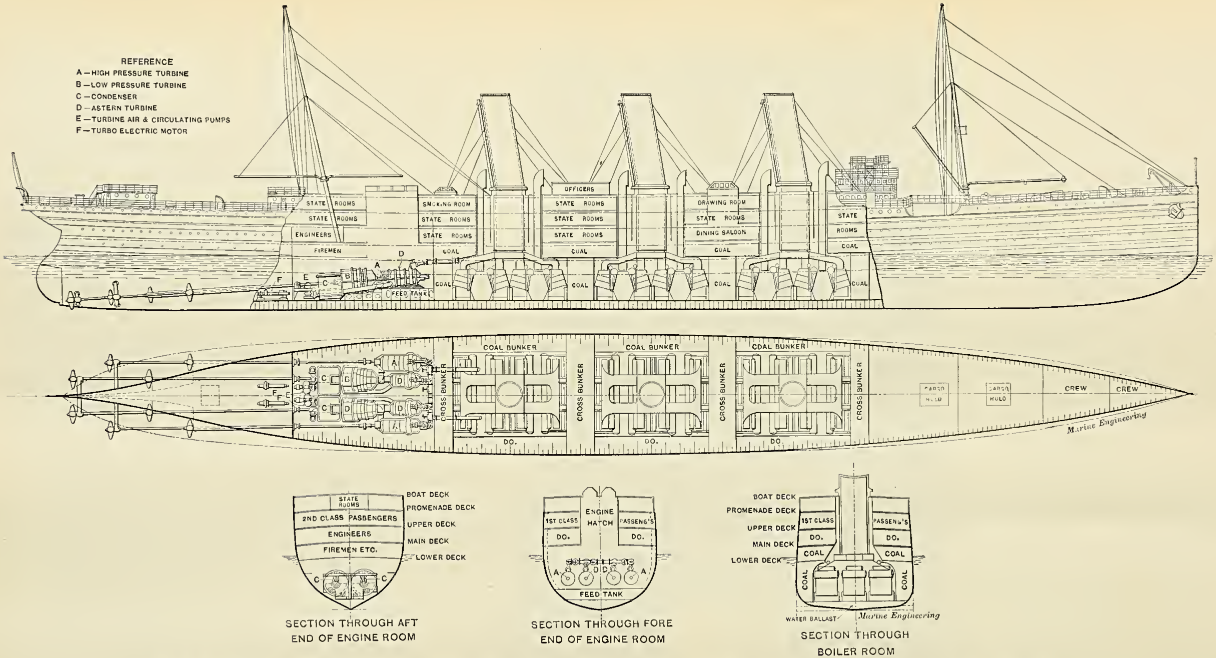
	Turbine Destroyer.	Regular Type.
Boiler room weights with water in boiler............	225,680 lb.	174,720 lb.
Engine room weights with auxiliary gear and water in condensers............	117,185 lb.	125,440 lb.
Weight of propellers and shafting, etc.	17,304 lb.	22,400 lb.
Totals............	360,169 lb.	322,560 lb.

Consequently the weight of machinery of the turbine destroyer figures out 30.01 lb. per indicated horse power, and that of the ordinary type destroyer exactly 53.76 lb. per indicated horse power. The hull of the turbine destroyer can also be made lighter, as the rotary motion of the turbine and absence of vibration make it possible to dispense with the added weights at the after end for structural strength, such as are demanded with the reciprocating form of engine.

It will be remembered that a series of observations were made by Prof. Ewing on the *Turbinia* when she came out, at the request of the owners. The important question of steam consumption, among others, received special attention. The indicator could not, of course, be applied to the turbine form of engine, and so the resistance of the vesel derived from tank experiments was used as a basis for computing the horse power at any speed up to a maximum of 32-knots. An exact record of the amount of feed, etc., used was also kept, and from the data thus secured the steam consumption for all purposes at the 31 knot speed was found to be 28 lb. per propulsive horse power. This, on the basis of 55 per cent of propulsive to indicated horse power, gave a steam consumption of 14 1-2 lb. per indicated horse power, and the coal consumption was rather less than 2 lb. per I. H. P. per hour.

How far these expected results will be reached or surpassed in the vessels under construction remains to be seen. Recent brief telegraphic reports seemed to indicate that the preliminary trials of one of the vessels were not satisfactory, but this is no criterion. Some detail of construction or equipment which might have no bearing whatever upon the efficiency of the machinery could, reasonably, be responsible for delay or disappointment.

No doubt the success of boats of the character of those now in hand would greatly aid in a more widespread adoption of the turbine form of propulsion. It is claimed for this type of engine that with larger engines, such as would be needed for full powered seagoing vessels, the conditions for the highest economy in steam with a minimum of weight, could be more easily met. While as yet no orders for the equipment of large mercantile vessels have been booked by the company, some work has been done in the direction of design. Plans have been prepared for an installation in a proposed ocean liner giving a total of 38,000 I. H.



PLANS OF PROPOSED TYPE OF OCEAN LINER FITTED WITH WATER TUBE BOILERS AND PARSONS TURBINE ENGINES—ESTIMATED SPEED, 26 KNOTS.
Plans originally drawn for Engineering, London.

P. and an estimate rate of sea speed of 26 knots. The proposed vessel would have these dimensions: Length between perpendiculars, 600 ft.; beam, extreme, 63 ft. 3 in.; depth, molded, 42 ft.; draught to bottom of keel, 28 ft.; displacement, 18,000 tons; total bunker capacity, 5,000 tons. Making a comparison as to machinery weights between the proposed vessel and a liner of similar dimensions with reciprocating engines of about 26,000 I. H. P. and Scotch boilers, the result would be:

	Turbine Liner Water Tube Boilers.	Regular Type Scotch Boilers.
Boiler-room weights with water in boilers.........	1,364 tons	2,225 tons
Engine-room weights with auxiliary gear and water in condensers............	822 tons	1,220 tons
Shaft and propellers......	210 tons	305 tons
Totals	2,396 tons	3,750 tons

The machinery weights of the turbine liner figure out 141 lb. per indicated horse power, and those for the regular type liner 323 lb. per indicated horse power. The comparative table shows a saving of 1,354 tons in the machinery weights for the turbine driven vessel over that with reciprocating engines on the same displacement, but the larger portion of this is to be credited to the water tube boilers. In the engine-room weights taken alone the difference in weight is almost 500 tons. Were less speed required and the turbine

liner powered to the extent only of the liner fitted with reciprocating engines, the saving in machinery weights would be very large and add greatly to the earning capacity of the vessel.

The advantages which, it is claimed, would result from the substitution of steam turbine machinery in a liner would be:

(1) A reduction of total engine-room weight to about one-half that of ordinary engines. (2) A small reduction in steam consumption per indicated horse-power. (3) Complete freedom from all vibration from the main engines, and a great reduction of vibration from the screw propellers. (4) A smaller engine-room staff to deal with the simpler and lighter engines and shafting. (5) Less consumption of oil and stores.

Commenting on these claims, *Engineering*, London (to which we are indebted for many of the foregoing particulars) remarks that the perfect balancing of the engines permits of very light engine-room foundations, and obviates that stress or strain on the hull, which is produced by the reciprocating forces of ordinary engines. The absence of lubricant from the internal parts of the engines is a benefit to the condensers and boilers. It diminishes the cost of cleaning and repairs, and enables very high boiler pressures to be used without risk. It is proposed that the steam should be reheated between the high and low pressure cylinders by coils of steel tubes containing steam at boiler pressure. Compound feed heaters, supplied with steam drawn from several points in the expansion in the main engines, would raise the temperature of the feed to above 212 deg. Fahr. The exhaust from the auxiliaries would also be added to one or more of the heaters. The trials of the *Turbinia* showed a total consumption of steam for all purposes of 14 1-2 lbs. per indicated horse power of the main engines at 31 knots, but in a liner the consumption would undoubtedly be less owing to the larger size and more perfect expansion, the higher boiler pressure, better vacuum and other minor details. Smaller size of the screw propellers diminishes vibration due to uneven action of the blades in the stream lines of the vessel. Smaller diameter also permits of some 8 ft. more immersion above the tips of the blades, so that the evils of screw racing in heavy weather will be mitigated, and the vessel better able to keep her speed.

With the steam turbine the turning moment on the shafting is absolutely uniform, and these engines have much more momentum (or flywheel inertia) than ordinary engines. They will, therefore, not gather speed so quickly should the screws top the surface, and the engine governor will have more time to come into action and prevent racing. The shafting is only about one-half the usual diameter for equal total indicated horse power, and can, therefore, be much more easily dealt with by the staff, and spare parts more easily carried. The four shafts are an additional safety against total break down of the engines; and should one of the engines break down the other three are not interfered with, as they are quite independent excepting as regards the steam supply, which is controlled by valves. The small headroom required for the turbine engines and their quiet working permits of cabins being placed over part of the engine-room.

In the accompanying engravings plans of the proposed liner can be read.

SHIPBUILDING PLANT OF WOLFF & ZWICKER, AT PORTLAND, ORE., ON PACIFIC COAST.*

The engineering and shipbuilding works of Wolff & Zwicker, lately brought to public notice in connection with the construction of torpedo boats for the U. S. Government, is situated at Portland, Ore., on the east bank of the Willamette River, eight miles from its confluence with the Columbia, and about ninety miles from the mouth of the latter river. The works originally were on the west side of the river, where a general machine business was carried on. In 1892 they were moved to the present location, on the water front, but shipbuilding was not taken up till about four years ago, when contracts were secured for building the torpedo boats *Fox* and *Davis*. These contracts were successfully fulfilled, and the progress made in this branch of work since then has been quite remarkable. And while the plant does not include everything to be desired, a very good equipment for moderate sized work has been built up.

Although some distance from salt water, the location is good, as these rivers are navigable for large vessels as far as Portland, and beyond, the Willamette (at Portland) is a quarter of a mile wide, and deep enough to float the largest ships. The current is very slow at ordinary stages of the water, as the river after tumbling over the great falls at Oregon City, twelve miles away, is much wider and deeper than above them.

Both wooden and steel ships are constructed in the yard, the former being preferable in some respects for river traffic, of which there is a great deal on these large rivers. There is an abundance of fine ship timber near by, and a steam saw mill, where it can be cut from the log, forms part of the equipment.

The works are quite complete in themselves, consisting of machine, pattern, boiler, blacksmith, and copper shops, foundry and shipyard. There is also a well stocked store room, the distance from manufacturing centers making this a necessity.

In the illustrations there is given a partial view of the shops and yard. Small craft, such as the torpedo boats before mentioned, are constructed on the partially covered ways, which can be seen running along the side of the shops. The bending floors are under the same roof as the boiler shop. The larger engraving shows half the machine shop to the left, and the foundry is hidden by the machine shop. It also shows the piling now being driven, to support ways for building large vessels. The smaller view was taken from the bridge seen in the larger picture, and looking down the Willamette, showing the U. S. torpedo boat destroyer *Goldsborough*, now in course of construction, receiving her Thornycroft boilers. Work need not be transported far, as everything is close to the water front. The shears on the dock can handle 50 tons. The legs are of wood (Douglass fir); the foot of the inner leg is movable, and operated by a power driven screw, so that the head of the shears may be swung out over a vessel, or drawn in over the dock. It does its work admirably, and the legs give an idea of the fine spars to be had in this section.

The machine shop employs sixty men at present, and while not fitted with very large tools, can handle some

* By our own special correspondent.

good sized work, as shown by some large gate valves just completed. These valves are for an 84-in. water main and weigh fifteen tons when completed. The facilities for handling work in the shop are not as good as might be, mostly owing to the fact that the shop has outgrown the work it was originally intended for. In the shop stand the engines for the *Goldsborough* nearly completed. The workmanship and finish on these engines are certainly first class. The shop is driven by electricity, from Oregon City falls, but has steam power also in case of an emergency. It is equipped with compressed air and hydraulic systems, for the operation of portable tools, hydraulic presses, etc.

The foundry employs forty men. It has two cupolas and can cast twenty tons a day. The handling is done with large hand power jib cranes, with which the shop is well equipped. There is also a brass foundry which can cast 3,000 lbs. at one pouring. The pattern shop employs twenty men, and is well equipped with power tools. There is also a good stock of standard patterns, the greater portion of which is for other than marine work, such as mining and mill work, and which forms not an inconsiderable portion of the product.

The boiler shop is very well fitted out. There is a good assortment of medium sized vertical rolls, and one large set of horizontal rolls, 16 1-2 ft. between housings, for heavy plate. There is a good assortment also of punches, shears, bevel shears and gang punches, the largest machine being able to punch a 6-in. hole in 3-1 in. plate. There is also a small plate planer, a small hydraulic bending machine and a number of portable hydraulic riveters and other portable tools. A large hydraulic riveter, having a gap 8 1-2 ft., and capable of driving 1 1-2 in. rivets, is now being erected, which, with the five small hydraulic riveters already on hand, makes this portion of the plant quite complete. A pneumatic system operates the portable tools for chipping and calking. The yard is fitted out with the necessary furnaces and bending floor.

The blacksmith shop has eight fires, and is equipped with good bolt headers for small work, and a large machine operated by hydraulic power for bolts up to 3 in. dia. There is also at present a 600-lb. steam hammer, a larger one being a necessary and contemplated improvement. Altogether about 300 men are now employed, the works being very busy.

VIEWS OF SHIPYARD OF WOLFF & ZWICKER, AT PORTLAND, OREGON.

Among other vessels built by this firm might be mentioned the *Sampson*, a tug boat 125 ft. long, the U. S. torpedo boats *Davis* and *Fox*, and two steel lightships for the U. S. Government. One of these ships is stationed on the Columbia River bar, the other near the entrance to San Francisco bay.

The officers of the company are: President, F. Wolff; Vice-president, J. E. Wolff, Secretary, F. E. Zimmerman. The Superintendent and Chief Designer is F. A. Ballin, formerly with the Detroit Dry Dock Co.

STERN WHEEL RIVER STEAMBOAT FOR THE KLONDIKE TRADE.

Gold discoveries in the Klondike region called into existence a large number of vessels for river service, many of which were wrecked or lost, while others put in use successfully made money for their owners. An interesting boat of this latter class is the *Willie Irving*, a stern wheel steamer plying on the upper Yukon River between Dawson City and White Horse Rapids, the head of navigation. This vessel is of the following dimensions: Length of hull, 80 ft.; beam, 20 ft.; depth of hold, 3 ft., and draught ready for load, 12 in.

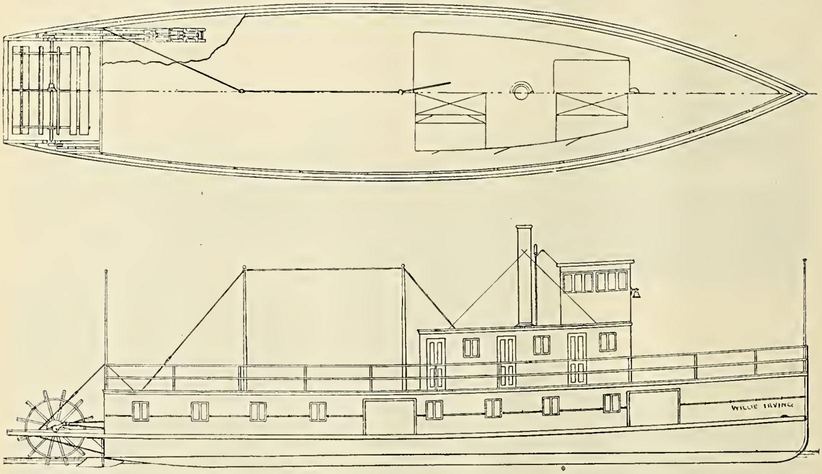
She was built by Joseph Supple, at Portland, Ore., about a year ago, and the entire outfit of driving machinery and accessories was especially designed and built by the Marine Iron Works, Chicago. Boat and machinery were shipped in knock-down shape to Skagway in such form that it was safely transported over the White Pass, and the boat re-erected and launched at Lake Bennett. Her owner, Capt. E. W. Spencer, of Portland, Ore., after thoroughly investigating the dangers of Miles Canyon and White Horse Rapids, decided to take her to Dawson. He was warned that it would mean destruction for the boat and death for the crew, but he had navigated on swift waters before and felt sure of himself and his boat. He knew there was sufficient depth of water, and that safety depended upon maintaining perfect control of the craft. After a few short runs on Lake Bennett and tributary waters to test her machinery and steering qualities, a start was made down the river with a load of passengers and freight for Dawson. The exciting run was made safely without causing a mishap, and he arrived at Dawson with passengers and cargo in fine condition. The receipts from freight and fares more than equalled the entire cost of boat and supplies.

At Dawson City Capt. Spencer was offered a price for the steamboat, and as it represented a clear and quick profit on his enterprise he accepted. Her new owner made ten trips between Dawson and White Horse Rapids during four months last season with receipts of $127,668.00—an unusual amount for an 80 ft. steamer, even for river service, in a land of high prices.

The boat proved to be a large carrier, stiff and speedy, and a close and easy handler in swift water. Her average time on the up river trip was 7 days.

When it is considered that no piece or part of boat or machinery or outfit was so heavy that two men could not transport it over White Pass, or any timber or section over 24 ft. long, it will be apparent that the construction was peculiar.

The upper works consisted of a single cabin the full length from the stem to stern, with pilot house and texas. The cabin floor or main deck was carried 20 in. below the guard, this being necessary on account of the variable and violent winds that cause much trouble to navigators on Lake Bennett and tributary waters.



STERNWHEEL STEAM BOAT WILLIE IRVING, FOR YUKON RIVER TRADE.

Some of the details of construction follow: Keel, 1 1-2 in. by 8 in., in four pieces, butted between frames: frames, 2 1-2 in. by 2 1-2 in., bent oak, set at 20 in. centers—when shipped these frames were held to form by wires instead of cleats, to lighten weight and lie together more compactly: Floors of Oregon pine, 2 1-2 in. by 2 1-2 in., bolted to the frames, with four screw bolts in each frame: Center keelson of three 1 1-2 in. by 8 in. timbers set on edge and bolted through and through, making it as stiff as a solid stick: Side keelson of two 1 1-4 in. by 10 in. pieces set on edge, and bolted through like center keelson: Center keelson fastened with two bolts through each floor stick: Cylinder keelsons four pieces 4 in. by 6 in. by 20 ft. long: Stem of oak re-enforced with a knee of Oregon pine: Clamps and also sheer 1 in. by 8 in.

Oregon pine: Shelf 2 1-2 in. by 2 1-2 in.: Bilge strakes 2 1-2 in. by 5 in.: Cross keelsons 2 1-2 in. by 2 1-2 in. every 10 ft., set on top of fore and aft keelsons, with knee at each end bolted to bilge strake, clamp sheer and frame: Deck placed on a level with these cross keelsons; decking of 1 in. lumber laid athwartships, resting on stringers laid on the fore and aft keelsons: Bottom planking 1 1-2 in. by 12 in.: Side planking 1 in. by 5 in.: Transom 2 in. by 12 in.: Knees used to strengthen the frame and planking all butted between frames.

The vessel is fitted with three balanced rudders. The entire skeleton of the hull was put up with carriage bolts when erecting it at the Portland boat yard. The holes were all drilled full size, but the bolts used were 1-16 in. smaller in diameter than those put in at final erection, thus avoiding undue strain to the lumber and facilitating taking down.

The total amount of lumber used in the completed boat was 8,800 ft., being principally choice Oregon pine, and the results have proven that it was all put where it did the most good.

The engines were two 7 in. by 28 in. double ported, balanced piston valve, direct acting, stern wheel engines of the regular Marine Iron Works type. They were installed with their auxiliary bearings built on to the steel wheel and engine beams. When constructed they were fitted and lined up complete in the builder's shop and run by steam pressure under approximately the same conditions as when installed in the boat. The wheel was 9 ft. 9 in. dia., with buckets 9 ft. long and 13 in. wide. There were twelve of these, each 1 1-2 in. thick. With 200 lbs. steam pressure and 36 engine revolutions per minute the boat attained a speed of about 12 miles per hour. The steel stern wheel shaft was 3 3-4 in. dia., in two sections, the steel coupling forming also the central paddle wheel flange.

Steam was raised in a Roberts water-tube boiler which was built for 250 lbs. maximum pressure per square inch. The boiler was fitted with an extra deep fire box for burning wood. Auxiliaries included a "Marine" outside packed plunger steam boiler feed pump, such as is supplied for use with gritty water. Also injector, test pump, sea cocks, bilge syphons, and an independent feed water heater, all arranged with special reference to the service for which the *Willie Irving* was built.

Another steamer (the *Scotia*) practically a duplicate of the *Willie Irving* has just been completed for Capt. Spencer by the Supple Shipyard, Portland, Ore., and Marine Iron Works, Chicago; the machinery consisting of a pair of 7 1-2 in. by 28 in. double ported balanced piston valve engines built onto steel wheel and engine beams. This new boat equals, and perhaps exceeds in general efficiency and speed the *Willie Irving*, and though she is a trifle heavier craft, her machinery represents an increase of about 18 per cent in power. Her actual total weight, inclusive of cabin and upper works, is 59,000 lbs., being just 12,000 lbs. heavier than the *Willie Irving*, the hull measurements of the two boats being the same. The *Scotia's* paddle wheel is 10 ft. 3 in. dia. outside of the buckets and 9 ft. 4 in. long. Each of the twelve buckets is 12 in. wide by 1 1-2 in. thick.

METHOD OF OPERATING SEACHLIGHTS MORE EFFICIENTLY BY USE OF DYNAMOTERS.

BY ALTON D. ADAMS.

The increasing use of electric light and power on board ships of both the war and merchant type renders more important the question of the electric pressure at the dynamos and in the wiring. When the largest electric ship plants included only a searchlight and a few incandescent lamps, the first cost, power to operate and attendant losses were all small matters, and the pressure of distribution was naturally fixed at only a moderate amount above that necessary for the searchlight, which was the most important device to be served and the largest consumer of power. These early conditions have now been changed so that the searchlight, while still of the utmost importance in its field, consumes but a small part of the electric energy generated in many ship plants, and is a mere fraction of the total cost. On large ships electric plants are now operated, each of several hundred horse-power capacity, and in view of the extending use of electric motors for auxiliary power on both war and merchant ships, equipments of more than 1,000 horse-power capacity may be expected in the future.

These changed conditions make an increase of the electric pressure of ship plants from 80 to 110 volts, and in some cases to 220 volts, desirable, not only because of the losses in resistance coils used with searchlights, but to a greater extent because of the material reduction in first cost, the increase in efficiency, decrease in weight, and better operative conditions made possible in other parts of the electric plant by the higher pressures. Several tons of insulated electric wires are required in a ship plant of medium size, at 80 volts pressure, and the cost of these wires will vary from about $800 to $1,500 per ton, according to size and quality. The loss of pressure in electric wires between the dynamos and the lamps or motors should be kept as small as practical, because as much variation of pressure and many times more change in candle power will take place at the lamps as there is loss in the wiring between no load and full load. This variation in volts at lamp terminals is to be avoided, not only because of the greater resultant variation in light, but also because the life of the lamp is much shortened by such changes.

While it is thus desirable to have the loss of pressure small between dynamos and lamps, the fact that the weight of wire increases in the same ratio that the last pressure decreases is a strong motive to proportion circuits for greater loss than is desirable. Now, with a given load and fixed energy loss, which corresponds to a constant per cent of pressure loss in wiring, the weight of copper to wire a certain ship varies as the square of the volts at which the system is operated. Suppose then that to wire a given ship with a certain percentage of loss in conductors, 3 3-4 tons of copper are required for an 80-volt system, then by using the 110-volt system less than 2 tons of copper will be necessary, while with the adoption of the 220-volt system the weight would be reduced to about 1-2 ton. These ratios being subject to a slight variation on account of the probable differences of the weight of insulation, which does not vary in the same ratio as the size of the conductor.

A practical result of this law is to encourage a small drop in pressure between dynamo and lamps when the

higher pressures are used. Thus, in the case just cited, a drop of 4 per cent. in pressure might well be permitted at full load in the wiring for the 80-volt system. Were 220 volts E. M. F. selected, the drop should be reduced to not more than 2 per cent, and even then a saving of about three-fourths the former weight of copper would be effected. The fact that the areas of brush, commutator and switch contacts decrease in about the same ratio that the operating pressure increase for a given capacity of plant is another argument for the higher voltage, especially in large ships, where auxiliary motors are coming into use for many purposes. Opposed to these higher pressures is the searchlight, capable of using only about 50 volts pressure at its terminals, and subject to some disadvantages if operated from pressures greatly beyond present practice, by means of interposed resistances. Aside from the matter of unsatisfactory operation on comparatively high potential circuits, the energy lost in the necessary resistance is to be considered.

With large searchlights taking 100 amperes, as in use on the U. S. battleship *Iowa*, for example, this loss may be considerable. Of the energy drawn from the circuit the searchlight only uses $50 \div 80 = 63$ per cent with the 80-volt system; $50 \div 110 = 45$ per cent with the 110-volt system, and $50 \div 220 = 23$ per cent with the 220-volt system. The remainder—37, 55 and 77 per cent, respectively—of the energy in the searchlight circuit is wasted in idle resistance coils. As a large ship may have several of these lamps in use at one time (the *Iowa* is equipped with four), it is evident that some means other than the present must be adopted before the higher voltages will become common in ship systems. Happily, means are not wanting whereby searchlamps may be operated in an economical and satisfactory manner from systems using any of the above or even higher electric pressures.

To render the searchlight independent of the voltage of the system from which the power for operation is drawn, some device must be employed to take electric energy at the available pressure and deliver it with small loss to the lamp at a pressure of about 50 volts. This can be accomplished by either the motor-dynamo or the dynamotor. The motor-dynamo consists of an electric motor and a dynamo, mechanically connected, and frequently constructed on the same base, with a common armature shaft and bearings, though the armature cores and armature coils, also the magnet cores and coils, must be distinct. The motor windings of the combination take current from the supply mains at any desired pressure, and the dynamo windings deliver current at any other pressure required.

Pressure delivered by the dynamo windings can be regulated with changes in load so as to increase, decrease or remain constant, by changing the exciting power of the dynamo, magnet coils, either through compounding or the use of a rheostat in the shunt. Where it is desired to operate several searchlights from one auxiliary machine the motor-dynamo will, perhaps, be found best suited to the purpose, as the pressure of the dynamo coils may be held constant at a point just high enough to permit regulation by a resistance coil in the circuit of each lamp, say 60 to 70 volts, no matter whether all the searchlights are connected at one time or not.

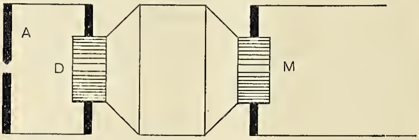


Fig. 1.

Taking the efficiency of the motor-dynamo at 75 per cent., and allowing the dynamo coils to work at a pressure of 60 volts, the lamps will be able to use $(50 \div 60) \times .75 = 62$ per cent of the energy taken from the line, or almost exactly the same as in the present system of working searchlights from 80-volt systems.

This method, with one large motor-dynamo to operate all searchlights, will permit the use of any desired pressure in electric ship plants, and give the same efficiency as is now had with the 80-volt system. It is desirable, however, to increase this efficiency, and the necessary means are at hand—the dynamotor.

A dynamotor is an electric machine with one armature core and one field magnet, but with two independent windings on the armature and two commutators. One winding of the armature takes current from any available supply and runs the machine as a motor, while the other winding generates the pressure and current for which it was designed. As both windings work on one armature core in the same field, a constant pressure cannot be maintained at the dynamo terminals if the load increases, but this property is well suited to searchlight operation, as a constant current, but not a constant pressure, is required in the lamp. By the use of a dynamotor for each searchlight the resistances in series with

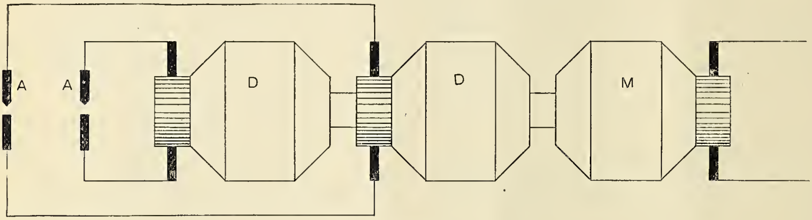


Fig. 2.

the lamp may be eliminated and the dynamo winding of the machine designed for 50 volts, the pressure necessary for the lamp under normal conditions of the arc. Small dynamotors corresponding in capacity to a medium or large searchlight can be had with 80 per cent. efficiency, and as no energy is wasted in resistances, the lamp in this case uses 80 per cent. of the energy taken from the line, no matter at what pressure the plant is operated, or about 80 — 63 = 17 per cent. more than it is possible to obtain with a low pressure of 80 volts and without a dynamotor. As the dynamotor has but one field magnet, armature coils and set of magnet coils, its efficiency in small sizes will usually be from 5 to 10 per cent higher than that of equivalent motor-dynamos, whose use as above is therefore to be preferred when an independent machine is desired for each searchlight. Where it is desired to provide for two searchlights in one machine, however, nearly equal results can be had with a motor-dynamo consisting of one motor and two dynamos, each dynamo operating but one lamp. So long as the dynamo end of a motor-dynamo, or the dynamo winding on the armature of a dynamotor, is designed to operate but one searchlight, the use of resistances in series with each lamp is unnecessary, as the dynamo will regulate automatically, lowering the E. M. F. of the lamp circuit when the carbons move close together and the current increases. If more than one searchlight is to be operated in multiple, the E. M. F. at the dynamo terminals must be kept nearly constant, as it cannot follow the variations of all the lamps. These variations must be provided for by a resistance in series with each lamp, as in the first arrangement suggested, where one motor-dynamo operates several lamps. Two or more searchlights might be operated in series by one dynamo of motor-dynamo set, so designed as to regulate for constant current, whether one or all the lamps are in use, but the special construction necessary to such regulation would probably not be warranted by the circumstances.

As resistances in series with lamps change electric energy into useless heat, it seems better to avoid their use and to provide a dynamo of a motor-dynamo set, or a dynamotor for each searchlight to be operated, except perhaps in the case of the smallest sizes.

Fig. 1 shows the connections of a dynamotor armature, the dynamo commutator, *D*, being connected directly to the searchlight, and the motor commutator, *M*, to the supply line of any desired pressure. Fig. 2 shows the connections of a motor-dynamo set, with two dynamos driven by one motor; the two dynamo commutators and armatures, *D*, are each connected with a searchlight, and the motor armature, *M*, with the supply mains. Motor-dynamos and dynamotors effect so large a saving and are so readily applied to the above purpose that their extended use with searchlights on large ship plants seems certain to come with and facilitate the necessary application of higher pressures.

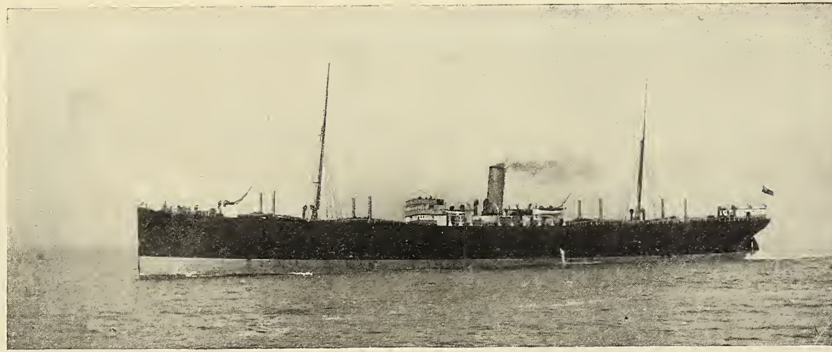
The British battleship *London*, 15,000 tons displacement, was launched at Portsmouth dockyard recently, where she had been laid down December, 1898. Her armament will include four 12 in. breech loaders, twelve 6 in. rapid fire guns, and nearly forty rapid fire guns ranging in size from 3 pounders downward.

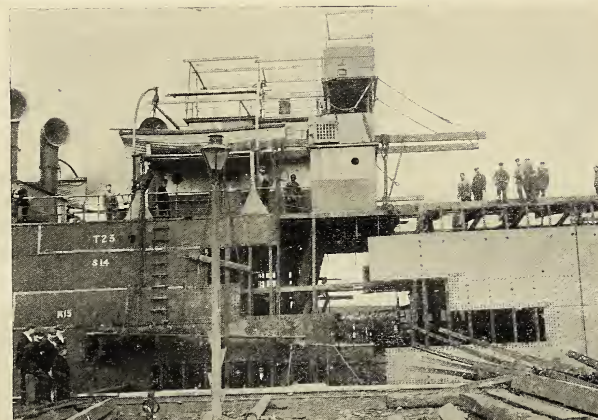
Reconstruction of S. S. Milwaukee.

The reconstruction of the British steamship *Milwaukee* in the American trade is a remarkable and extremely interesting engineering feat. Our subscribers will recall a view of this vessel, or rather of the after portion of it, which we published, together with an account of the mishap which befell the vessel several months ago. While on a voyage from the northeast coast of England to New Orleans in ballast the vessel went on the rocks near Peterhead, on the coast of Aberdeenshire, Scotland. The salvage company to which was intrusted the job of saving the vessel, if possible, found that her fore part was so tightly wedged in the rocks that to float her was impossible. As the after part of the vessel was uninjured it was decided to cut this away forward of the engine room bulkhead and tow the uninjured portion to the builders' yard, located on the River Tyne. More than 500 lbs. of dynamite was used for the purpose of separating the ends, and by placing small charges at suitable intervals around the hull at the desired point the after end was freed without mishap or injury. Then the end of the ship was towed bulkhead foremost from the scene of the wreck to the Tyne and it remained staunch. Probably the most extraordinary feature of this trip was the fact that the engines of the vessel were used to assist the tugs. When the after end reached the Tyne safely the construction of a new forward portion of the vessel was at once begun. The bow was launched and the two ends were then floated together (as shown in the engraving) until placed in dry dock and united into a complete vessel. The work of joining the ends was accomplished without difficulty, and after the job was completed and the vessel painted it was not possible to tell where the old work ended and the new begun. So carefully was the reconstruction planned and carried out that the chief dimensions of the vessel are not changed, and there is only six tons difference in the gross tonnage of the original vessel and the present S. S. *Milwaukee*. The *Milwaukee* was built by C. S. Swan & Hunter, at Wallsend-on-Tyne, in January, 1897, for Elder, Dempster & Co., of Liverpool, and her chief dimensions are: Length 470 ft., beam 56 ft. and depth moulded 34 ft. 9 in. and tonnage about 7,317 tons gross.

The salvage was effected under the superintendence of Captain Batchelor of the Liverpool Salvage Association, assisted by Captain Evans, the Marine Superintendent for the owners. Through the courtesy of the owners we are able to present to our readers, on the two following pages, reproductions of photographs showing the salved portion of the vessel, the work of reconstruction, and the completed vessel.

It is rather unusual for a steamship to be moved on the water and yet not in the water, but this feat was performed recently in New York harbor in the case of the steamship *Richmond*, of the Old Dominion line. The vessel was in a balance floating dry dock in Erie Basin, and the dock was towed a distance of about a half-mile to a new anchorage. The *Richmond* is a screw steamer of the following dimensions: Length, 210 ft.; beam, 33 ft.; depth, 21 ft. 6 in.; gross tonnage, 1,102 tons. The balance dock has a capacity of 3,500 tons.

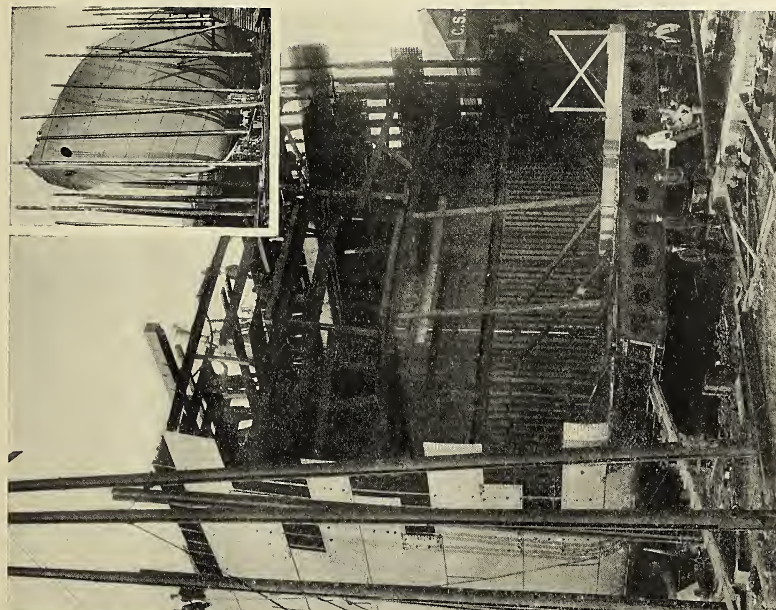




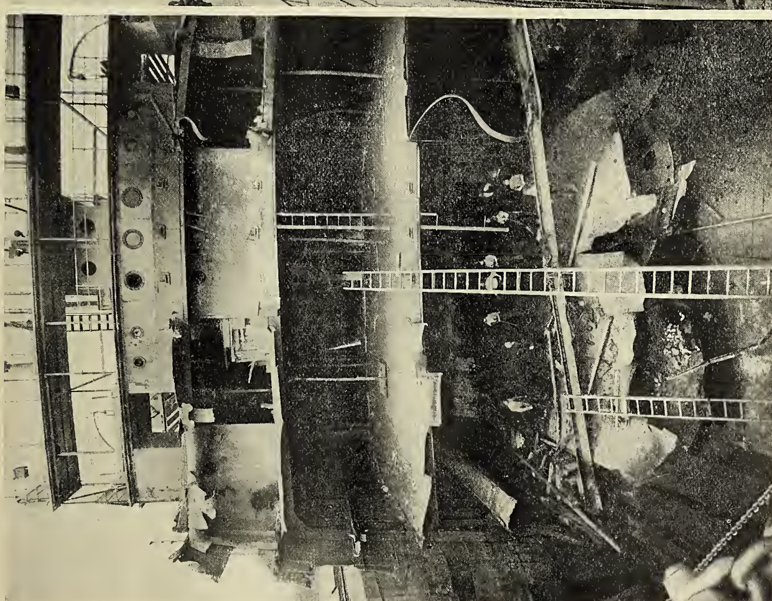
Original stern and new bow pointing in same direction.
Salved portion on its arrival in river Tyne.

S. S. Milwaukee as originally built and practically as reconstructed.
Original stern and new bow in place ready for the connecting plates.

ORIGINAL PHOTOGRAPHS SHOWING RECONSTRUCTION OF S. S. MILWAUKEE, BY COURTESY OF C. S. SWAN & HUNTER, SHIPBUILDERS, WALLSEND-ON-TYNE, ENGLAND.



Two views of the new bow on the stocks ready for launching.



Salved portions in dry dock, showing damage done by dynamite used in severing the two portions.

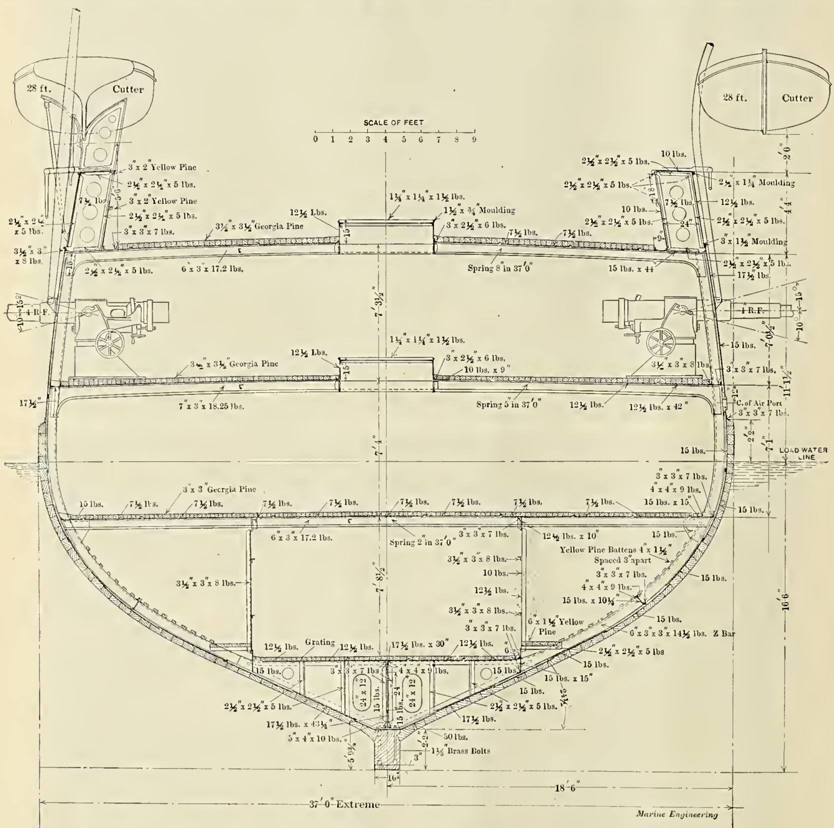
ORIGINAL PHOTOGRAPHS SHOWING RECONSTRUCTION OF S. S. MILWAUKEE, BY COURTESY OF C. S. SWAN & HUNTER, SHIPBUILDERS, WALLSEND-ON-TYNE, ENGLAND.

CONSTRUCTION AND EQUIPMENT OF THE U. S. NAVAL ACADEMY PRACTICE SHIP CHESAPEAKE.

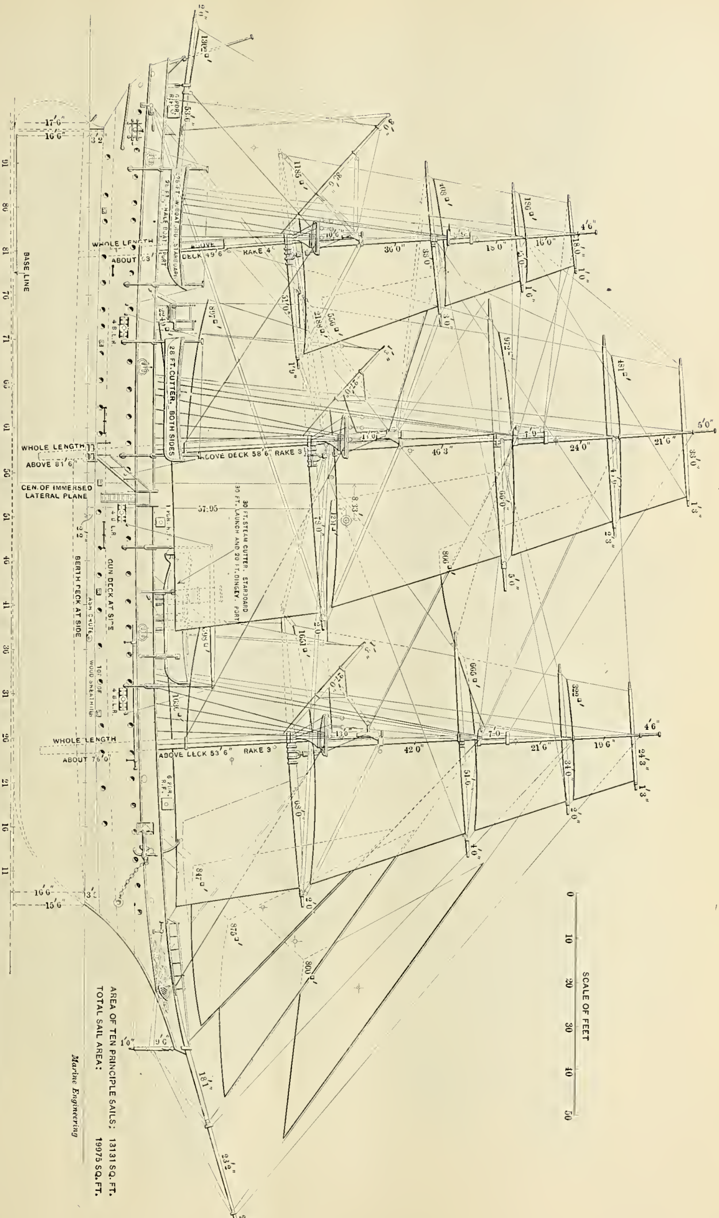
For many years the cadets of the U. S. Naval Academy at Annapolis have been compelled to make practice cruises in old vessels fitted temporarily for this purpose, but in reality unfit for the special purposes of training. In 1897, however, Congress took action looking toward the construction of a vessel exclusively for this use. The result is the *Chesapeake,* built by the Bath Iron Works and now fitting out at the Charleston Navy Yard, Boston, Mass. Under the advice of the naval officers immediately concerned, at the time, a sailing vessel was decided upon. We do not propose in this article to discuss the advisability of adopting an obsolete type of vessel for the purpose, but simply to describe her construction and arrangements. These and her battery comprise the modern features of the vessel.

Designs for the *Chesapeake* were prepared by the Naval Bureau of Construction and Repair, under the direction of the Chief Constructor, Philip Hichborn. She is the first sheathed vessel to be built in this country and the only sailing vessel that has been added to the Navy in over thirty years.

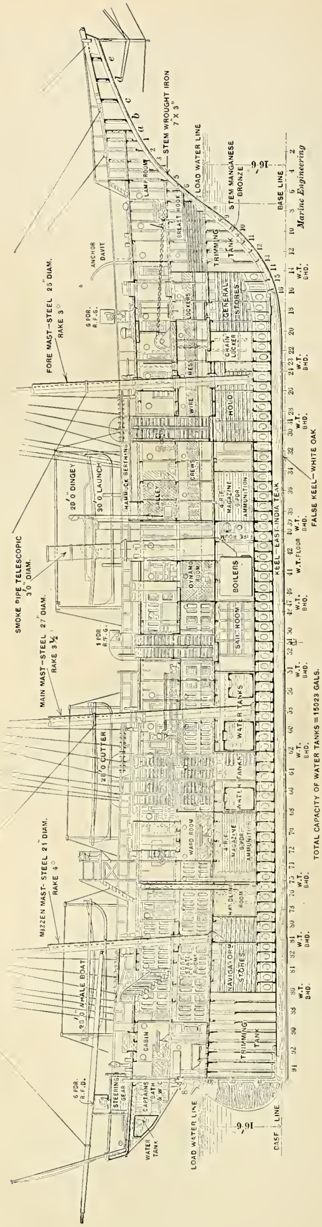
The original appropriation for the vessel made by Congress in 1897 was unfortunately confused. After deciding that a full rigged sailing ship was the proper type of training vessel for the cadets, the wording of the bill was such as to include propulsion by both sail and steam, although the estimate in the hands of the committee did not cover such a design. In amending the bill to exclude steam propulsion a great error was committed, as the appropriation was reduced to but $125,000, or one-half the amount required. The design



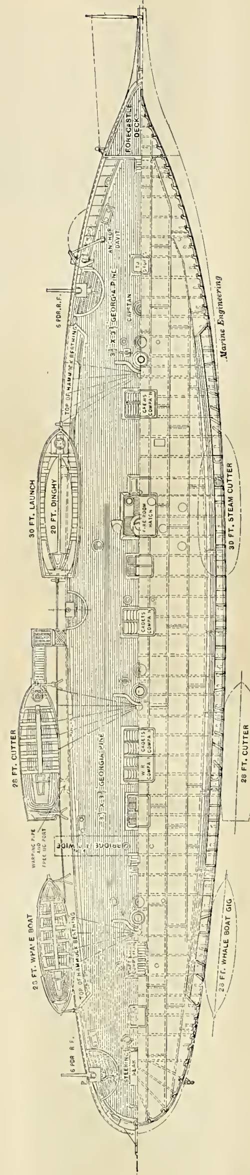
CROSS SECTION OF U. S. PRACTICE SHIP CHESAPEAKE FOR NAVAL ACADEMY.



SAIL PLAN OF THE NEW U. S. PRACTICE SHIP CHESAPEAKE FOR THE NAVAL ACADEMY—FIRST (STEEL HULL) SHEATHED VESSEL BUILT IN UNITED STATES.

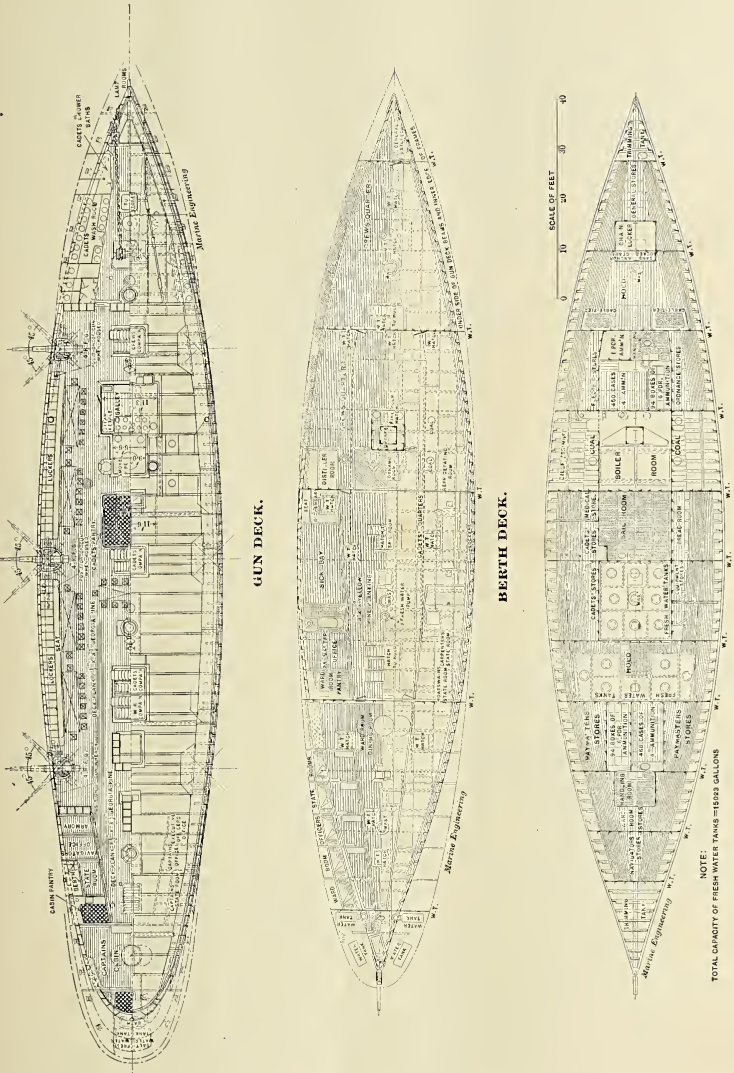


INBOARD PROFILE.



SPAR DECK.

PLANS OF THE U. S. SHEATHED PRACTICE SAILING SHIP CHESAPEAKE, FOR NAVAL ACADEMY, BUILT BY THE BATH IRON WORKS, LTD., BATH, ME.



GUN DECK.

BERTH DECK.

HOLD AND MAGAZINE.

NOTE:
TOTAL CAPACITY OF FRESH WATER TANKS =15023 GALLONS

PLANS OF THE U. S. SHEATHED PRACTICE SAILING SHIP CHESAPEAKE, FOR NAVAL ACADEMY, BUILT BY THE BATH IRON WORKS, LTD., BATH, ME.

was developed as originally intended, and the contract for the construction of hull and fittings was awarded to the Bath Iron Works March 16, 1898. Additional funds were made available in February, 1898, the total appropriation being raised to the required amount of $250,000. The keel of the *Chesapeake* was laid August 2, 1898. She was launched June 20 of the present year, and on July 11 she left the yard of her builders and was handed over to the U. S. Government at the Boston Navy Yard. The spars, boats, outfit and furniture have been made at the Boston Yard.

Following are the dimensions and the most interesting particulars concerning the hull of the *Chesapeake:*

Length over all	223 ft. 6 in.
" L. W. L	175 "
Beam, extreme	37 "
" molded	36 " 3 in.
Freeboard, ford	14 " 3 "
" aft	14 " 3 "
" amidship	11 " 3 "
Draft, mean	16 " 6 "
" aft	17 " 6 "
" ford	15 " 6 "
Displacement	1,190 tons
Area of midship section	378 sq. ft.
" " load water plane	4,570 " "
Tons per inch of immersion	10.86 tons
Meta-centric height	3.6 ft.
Range of stability	120 deg.
Max righting arm	2.5 ft.
" " moment	2,975 ft. tons
Angle of Max righting arm	58 deg.

The following general schedule of weights will also be of interest:

Hull and fittings	710	tons
Boilers, pumps, piping, etc	45	"
Armament and ammunition	68	"
Equipment and outfit	223	"
Coal	22	"
Ballast	123	"
Total	1,190	"

The *Chesapeake* is a very lean vessel with high freeboard, and closed bulwarks throughout her length. She has considerable deadrise, the angle of her floors being 25 deg. with the horizontal base line. There are three continuous decks, two of which are plated with steel throughout. The steel construction of this vessel is very heavy, and she is sheathed with 4 in. Georgia pine in addition to having a steel bottom and sides fully equal in scantling to any steel gunboat of her size afloat. The transverse frames are spaced 24 in. apart. For 3-4 length amidship they are formed of Z bars 6 by 3 by 14 1-2 lb. per ft., split at the bottom of the bilge. At the ends of the vessel frames of angle bar 4 by 3 by 8 lb., with reverse frames 3 by 3 by 7 lb., run from the keel to the main rail in one piece. The floors are 43 in. deep in the center. They are made of 15 lb. plate of bracket construction. The vertical keel is 43 in. deep by 17 1-2 lb., with double angles 4 by 4 by 9 lb. on the top, and double angles 5 by 4 by 10 lb. on the bottom. The flat keel is 52 in. wide amidship and 30 lb. per sq. ft. The top of the vertical keel connects to a 30 in. by 17 1-2 lb. flat keelson plate, and the floors between the fore and aft longitudinal bulkhead are plated over with 12 1-2 lb. steel plate, forming a tank. The shell plating is of 15 lb. plate throughout, with the exception of the garboard and sheer strakes, which are of 17 1-2 lb. plate. The outside plating is doubled forward in wake of the chafe of the anchors. The upper or spar deck is plated over with 7 1-2 lb. steel plate, the stringers being 44 in. wide by 15 lb., connected to sheer strake by a 3 1-2 by 3 by 8 lb. angle bar. The gutter waterway is 9 in. wide, the inner angle up to which the plank is worked being 3 by 3 by 7 lb., and the outer angle which connects to the hammock berthing is 3 1-2 by 3 by 8 lb. The planking is of 3 1-2 by 3 1-2 first quality Georgia pine. The spar deck beams are 6 by 3 by 17 lb. angle bulbs located on every alternate frame; they have a camber of 8 in. in 37 ft. The hammock berthing extends on this deck for a distance of 136 ft. amidships. It is 4 ft. 4 in. high and 24 in. wide, the apertures on the upper inner side being 18 in. wide. The hammock berthing outside plating is of 12 1-2 lb. plate. The inner and top plate is of 10 lb. plate, and the divisions are made of 7 1-2 lb. plate, the angle bars being 2 1-2 by 2 1-2 by 5 lb. throughout. The middle deck—main deck—or gun deck, as it is called, has a 42 in. by 12 1-2 lb. stringer plate. The beams are 7 by 3 by 18 lb. angle bulbs located on alternate frames, with a camber of 5 in. in their midship length. The gun deck plank is 3 1-2 by 3 1-2 first quality Georgia pine. The lower or berth deck is plated throughout with 7 1-2 lb. plate, the stringer being 15 in. by 15 lb., connected to the ship's framing at side by 4 by 4 by 9 lb. angle bar, and to ship's plating by 3 by 3 by 7 lb. angle bar. The beams are of angle bulbs 6 by 3 by 17 lb., placed on alternate frames, the camber being 2 in. in 37 ft. The spar and gun deck beams have welded knees and the berth deck beams are connected to the framing by bracket knees. The wood keel of the *Chesapeake* is of East India teak, sided 16 in. and molded 26 in. It is well secured to the flat keel by composite screw bolts 1 3-8 in. dia., tapped into the steel plate with lock nuts on the inside. The false keel is of white oak 3 in. thick, worked in 12 ft. lengths and well fastened by composite spikes to the main keel. The outside planking extends from the keel to about 26 in. above the water line amidship, sheering up 15 in. forward and 12 in. aft. This planking is of 4 in. Georgia pine throughout, the upper edge being covered by an angle bar 3 by 3 by 7 lb. The plank is fastened to the steel shell by 3-4 in. brass screw bolts fitted with nuts on the inside. These bolts have a tensile strength of 42,500 lbs. The copper sheathing runs to a line 3 in. below the upper edge of the wood outside planking. The upper part of this surface is sheathed with 28 ounce copper, the bilge section is covered with 26 ounce copper, and the bottom is sheathed with 24 ounce copper.

Fore and aft w. t. wing bulkheads 62 ft. long are worked in the hold amidships. These bulkheads inclose the magazine forward, the boiler room, the sail room, and the fresh water tanks aft. In the wings are the electric stores, cadets' stores, medical stores and coal bunker on the port side, and the ordnance stores, bread-room, warrant officers' stores, equipment stores and coal bunker on the starboard side.

The boiler room is 16 ft. long and 14 ft. 6 in. wide. In it are located two steel Scotch boilers 8 ft. long and 6 ft. 6 in. dia., with single furnaces; a condenser with 150 sq. ft. of cooling surface; an air and circulating pump 4 1-2 by 5 by 6 by 6; a fire and bilge pump 10 1-2 by 6 1-2 by 10; feed pump 4 1-2 by 3 by 6, and a feed tank. The smoke pipe is 3 ft. outside dia., the height above the top of grate being 42 ft. There are 15 fresh water tanks in the hold. The average size of these in-

dependent tanks is 6 ft. by 4 ft. by 6 ft. The total capacity of these tanks is 15,030 gals. of fresh water. The after magazine is located aft of the tank spaces, the paymaster's stores being on each side of it in the wings.

The ward room stores and navigation stores are located aft, and the general stores and chain and sand locker are located forward. A trimming tank is located at each extremity of the vessel. On the forward berth deck is located a general storeroom. Then comes the crew's space, divided into two parts by a w. t. steel bulkhead, aft of which is the fire room hatch, dynamo room with 2 generators (the plant being in duplicate), distilling room and refrigerating room. The evaporator shell is 4 ft. dia. and 5 ft. 6 in. long over all, size 2-s-120. The distillers are 2-s-98. The evaporator feed pump 6 1-4 by 4 3-8 by 8, and the distiller circulating pump 3 by 2 1-2 by 4. In the refrigerating room a one ton Allen dense air ice machine is fitted.

On the port side of the berth deck amidships are located the dispensary, sick bay, with bathroom and w. c., paymaster's office and ward room pantry. On the starboard side the warrant officers' mess room, carpenters' and boatswain's rooms, and quarters for a few of the cadets. On the berth deck aft is the ward room, dining-room, ten staterooms and bathroom, complete in all respects. On the gun deck forward is the manger, with lamp room and small stores. Then comes the cadets' shower baths and dressing room, cadets' wash room, warrant officers' and ward room officers' w. c. on the port side, and the crew's w. c. and cadets' w. c. on the starboad side. A Hyde patent steam capstan windlass with wildcats for 1 1-2 in. chain is located between the wing w. c.'s. The cadets mess and swing their hammocks on the gun deck amidship. Here eight mess tables 12 ft. by 3 ft., with seats for fourteen at each table are carried. In the center of this deck are the galleys, pantries, etc., and aft are the executive officer's office, navigator's office, armory, captain's stateroom, cabin, bath, pantry and office. Six 4 in. r. f. g. are carried on the gun deck, three on each broadside, two forward, two amidships and two aft, each having 45 deg. angle of fire on each side of a line square with the center line of the ship.

The spar deck of the *Chesapeake* is a good clear deck fore and aft. A small monkey forecastle is worked forward, the space beneath it being used for the stowage of deck gear. Two 6 pdrs. are carried forward on the spar or weather deck, two are carried aft, and two 1 pdrs. are located amidship. A Hyde Robinson improved hand screw steering gear is located on the deck aft, the vessel having no steam steering gear. Seven boats are carried, viz.: a 30 ft. steam cutter, a 30 ft. launch, two 28 ft. cutters, a 28 ft. whale boat, a 28 ft. whale boat gig, and a 20 ft. dinghy.

The vessel has no chart or pilot house, but a large navigating bridge is located aft, just forward of the mizzen rigging. Pin rails, fife rails, topsail sheet bits, cavils, cleats, bits and fair leads, are located on deck to the best possible advantage.

The *Chesapeake* is a full rigged sailing ship, with three masts spreading 19,975 sq. ft. of sail all told; the area of the ten principal sails is 13,131 sq. ft. The fore truck is 130 ft. above the w. l., the main is 142 ft., and the mizzen is 115 ft. The following gives the lengths of the yards and fore and aft spars:

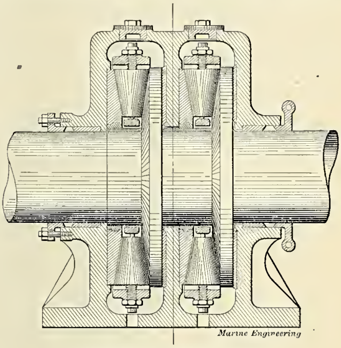
Fore lower yards	68 ft.
" topsail "	51 ft. 6 in.
" topgallant "	34 ft.
" royal "	24 ft. 3 in.
Main lower "	78 ft.
" topsail "	66 ft.
" topgallant "	45 ft. 9 in.
" royal "	33 ft.
Mizzen lower "	51 ft.
" topsail "	38 ft.
" topgallant "	25 ft.
" royal "	18 ft.
Fore spencer gaff	27 ft.
Main " "	27 ft.
Spanker gaff	35 ft. 6 in.
" boom	53 ft. 6 in.
Jib boom outboard	41 ft 3 in.

The center of effort of the sail is 8.33 ft. forward of the center of lateral resistance and 57.95 feet above the water line.

EXPERIMENTS ON THRUST BLOCK FRICTION—ROLLER BEARINGS AND PARALLEL BEARINGS.*

BY F. VON KODOLITSCH.

In the various text-books for marine engineers are to be found various data about the internal friction of marine engines, and we know approximately the proportion which exists between indicated horse power and brake horse power. But we know very little how much we lose in the thrust-block, tunnel bearings, and stern tube. To determine at least the amount of friction lost in the thrust-block, I have carried out a series of experiments to ascertain what percentage of the indicated horse power is lost by friction.



EXPERIMENTAL THRUST BLOCK.

Before I begin to describe how the experiments were carried out, I will give a description of the construction of the thrust-block itself.

As you can see by the engraving, this thrust-block is not of an ordinary design, but is a combination of a roller thrust-block for going ahead and an ordinary thrust-block with thrust collar and ring for going astern.

You will see that the distance from the center line of the thrust-block to the outside of the coupling is the

* Read before the Institution of Naval Architects, England.

same for each side; also the holding-down bolts are symmetrically placed in the center lines of the block. Moreover, there are in the two couplings no conical holes, but parallel ones, so that it is possible to use either the rollers for going ahead, and the white metal rings for going astern, or vice versa, by turning the shaft around. The object of this design is twofold. As this kind of thrust-block was a novelty to me, I wanted to secure by this design "a second string to my bow," so that in case the roller bearing should give trouble during the first voyage the whole bearing can be converted into an ordinary one by simply turning it around. The second consideration was produced by the intention to carry out the experiments which I am going to describe.

You will see by the engraving that on each side of the thrust-block is a sort of stuffing-box, and the whole block is cased in an oil-tight cast-iron box. This box is completely filled with oil to run the shaft in an oil bath. The experiments for ascertaining the friction produced with a full load on the block were carried out in the erecting shop. The dimensions of the marine engine to which this block belongs are as follows: 13 7-8 in high pressure, 22 1-4 in. intermediate pressure, 36 in. low pressure, by 24 in. stroke, and this engine develops 600 indicated horse power, at 136 revolutions per minute.

The ship travels at a speed of 12 knots. Applying now the formula for the indicated thrust, we find that to run the shaft in the shop under the same conditions as on board, it is necessary to place on top of the coupling a load of 11,047 lbs. As you will see, the shaft was placed in a vertical position in order to utilize the top surface of the coupling as a platform for applying the weights. On to the platform was fixed a small shaft of 2 1-2 in. dia., with a square head at the top of it. On this square head was applied a drill press with a pair of mitre wheels, of which the smaller pinion was driven by a universal joint attached to a telescopic shaft. At the further end of this shaft is again a universal ball joint, which is driven by an electric motor. By means of this arrangement it was possible to drive the thrust shaft at 136 revolutions with a load of 11,047 lbs., and I was able to determine how many horse power would be consumed by friction in actual running.

As you well know, an electric motor may be accurately indicated as a steam engine, if we place alongside of the electro-motor an amperemeter and a voltmeter. If we multiply the indicated amperes by the indicated volts, and divide by 736, we find the indicated electrical horse power.

But what we actually want is not the indicated electrical horse power, but how many foot-pounds were necessary for driving the loaded thrust-shaft at 136 revolutions. This would correspond to the brake horse power on the small shaft on top of the thrust shaft. The proportion between this brake horse power and the indicated electrical horse power is, of course, in this case, the efficiency of the driving apparatus. This was ascertained also by brake experiments independent of the thrust-block experiments.

A brake was applied at the end of the drill press and the number of amperes increased, and the brake correspondingly tightened up until the same conditions were obtained as in the case of the thrust-block experiments. The result of these experiments was that there existed an efficiency of 63 per cent between the indicated horse power and the brake horse power in the one case, and 67 per cent in the other case.

In the accompanying table are two columns, *A* and *B*. *A* shows the results obtained when rollers were used, and *B* the results when white metal rings replaced the rollers. The manner in which the experiments were carried out was so simple that it will require very little explanation. The first experiment, *A*, was made with rollers. The shaft was turned around at 136 revolutions with a load of 11,047 lbs., and the amperemeter showed 20.97 amperes and the voltmeter 100 volts; that means to say that we required 1,321 foot-pounds for turning the shaft. After this experiment the thrust-block with the shaft was turned round and fixed against the wall. The load was applied and the shaft again turned round at 136 revolutions.

RESULTS OF THRUST BLOCK EXPERIMENTS.

Revolutions per Minute.	Amperes.	Volts.	Indicated Electric Foot-Pounds.	Brake Foot-Pounds.	Efficiency of Motor and Gear.	Rollers A.	White Metal B.	Load.
						H.P.	H.P.	lbs.
136	20 97	100	2,097	1,321	63%	2.4		11,047
136	273.6	90	24,425	16,365	67%		29.75	11,047

The results are given in the second line of the table. In this case the efficiency of the motor and gearing was found to be 67 per cent.

To sum up the whole experiments, I found that in a marine engine of 600 horse power 136 revolutions and 12 knots speed of the ship, 29.75 horse power are lost in the thrust-block if of ordinary construction, and 2.4 horse power are lost if the thrust-block is made on the roller system.

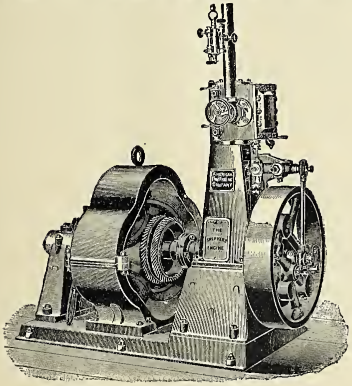
Large Dry Docks.—The largest dry dock in operation at the present time is located at Liverpool, and is known as the Canada Graving Dock. This dock, which was opened a few weeks ago, has the following dimensions: Length, 925 ft.; width at entrance, 94 ft.; depth over sill at high water, 32 ft. 6 in. The dock is equipped with three centrifugal pumps, which have a capacity of a little less than 1,000 tons a minute. With a vessel of 8,000 gross tons in dock these pumps emptied the dock in about 1 1-2 hours. The large dock at Southampton, Eng., known as the Prince of Wales Graving Dock, is of smaller dimensions, which are: Length, 750 ft.; width at entrance, 91 ft. 1 in.; depth over sill at high tide, 32 ft. 6 in. The new dock at Newport News, Va., will be about 900 ft. long.

U. S. S. Kearsarge.—The battleship *Kearsarge* reached New York September 17 after having run the builders' preliminary trial, upon which she attained a maximum rate of speed of 17.25 knots. This was while her bottom was foul. In New York she was placed in the U. S. dry dock, and scraped and painted, before proceeding to Boston, from which port she will start out on her official trial.

IMPROVED APPARATUS.

Direct Connected Lighting Set.

In the accompanying illustration there is shown a marine lighting set consisting of an Onondaga dynamo coupled direct to a Shepherd vertical engine. The dynamo is designed with great care for the purpose intended. The armature—upon which so much depends for the successful working of a machine—is built up of discs made from the best grade of charcoal iron. The

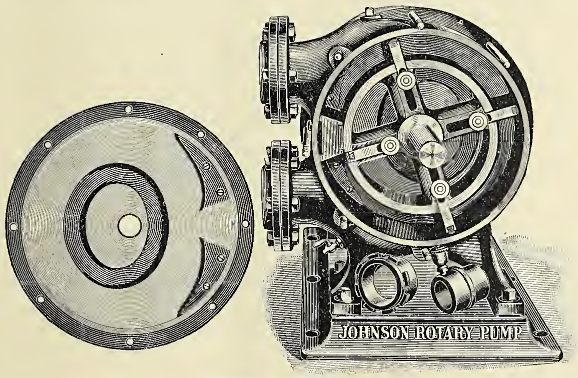


ONONDAGA DYNAMO, SHEPHERD ENGINE.

discs are brought together under heavy pressure, and are firmly held in place by heavy cast iron end plates, and slots are provided to receive the wire. The construction is such that when running a steady current of air enters the center of the core through the openings at each end, keeping the armature at an even temperature. The commutator is of generous proportions, and has a large brush contact surface made of the purest copper. The segments are mica-insulated, and the commutator is thoroughly ventilated. The shaft is of forged steel. Carbon brushes are used, and the brush-holder is designed to give a uniform bearing surface with light pressure. The load may change from zero to full load without causing any sparking and without shifting the brushes. The bearings are self-adjusting and self-oiling, machined with great accuracy. The engine used is the Shepherd type, described in a recent issue, and manufactured by the American Fire Engine Co., Seneca Falls, N. Y. The generator is manufactured and supplied by the Onondaga Dynamo Co., Syracuse, N. Y.

Johnson Rotary Pump.

In the illustration there is shown a compact form of pump known as the Johnson Rotary Pump, which in operation gives a continuous stream of water. It consists of an outside shell, with suitable parts for connecting suction and discharge pipes; two side plates with cam attached to each, and inside a circular spider or piston in which are held the piston heads which are operated by the cams. The piston does not bear at any point on the inside of the shell, so that there is no wear in this portion of the pump, which would in time allow the fluid to be carried from the inlet to the outlet. The separation between these orifices is provided by a butment which is fitted with a movable bronze shoe thrown forward by springs against the outer rim of the piston. In this way the wear is continually taken up and a tight joint maintained. Power can be applied by gears or pulleys secured to the shaft which is keyed to the piston, or this can be coupled direct to a vertical engine. The pump is made in a variety of sizes up to 6 in. dia. of suction and discharge pipes. A pump of this size occupies 27 in. by 50 in. floor space, and weighs 1,100 lbs. The speed of running is 125 revolutions per minute and the capacity at this rate is 750 gallons per minute. The pump is especially useful for wrecking, fire ballast or drainage uses. The maker states that it will pass dirt, coal dust, chips or any light obstruction without lessening its efficiency, and there are no valves to clog or derange. In cases where a long lift is needed a foot valve can be used. The pump is manufactured and marketed by the Davis Johnson Co., 41 West Randolph St., Chicago, Ill.



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MERCHANT shipbuilding the world over during the year 1898 is carefully classified and tabulated in the recent issue of Lloyds Register of British and Foreign Shipping, which organization has, of course, special facilities for the gathering of accurate data. An examination of these figures is always an interesting matter, and it is comforting this year to note that the United States has resumed second place in the quantity of tonnage put out. It will be remembered that when the totals for 1897 were footed up the second place was taken by Germany, that nation having turned out 81,107 tons more than the United States. For 1898, however, the figures give the United States a grand total of steam and sail of 169,196 tons, Germany coming after with a total of 136,186—33,010 tons less. This represented for Germany a decided falling off from the previous year in tonnage, though there was an increase of nine in the number of vessels built. In our case there were seventy-eight more vessels built in 1898 than in 1897, and the increase amounted to 96,615 tons. We have thus regained second place, which we held for the years 1895 and 1896, and from present indications there is little doubt but that this position will be retained when the totals for 1899 are secured. The figures used represent the gross register of steamers and net register of sailing vessels, and no account is taken of sailing vessels of less than 100 tons net register, or of steamers of less than 100 tons gross register. The United States total was made up of eighty-four steam vessels of 107,785 tons, and of fifty-six sailing vessels of 61,411 tons. Of these there were four vessels built on foreign orders; two small sailing vessels built for German owners and two steamers on Hawaiian orders—a total of 1,173 tons for the four. On the other hand American orders exceeding 3,000 tons were placed with British builders. Our steam tonnage for 1898 showed an increase over the preceding year of fifty-one vessels, and of 70,810 tons. In the case of sail tonnage the increase in number of vessels built was twenty-seven and in tonnage 25,805 tons. Of the total sail tonnage forty-nine vessels of 36,756 tons were built of wood and seven vessels of 24,655 tons were built of steel, all of the latter being over 2,000 tons net register. Our large sail tonnage includes vessels of the tow barge type, which by courtesy only can be called sailing vessels. These are being built in increasing numbers, especially for sea coast trade and are proving very remunerative. Coming now to the head of the list, this as customary was taken by the United Kingdom with 690 vessels of a total tonnage of 1,303,894; a very considerable increase over the figures for 1897 (907,611 tons), and a large gain also over the total for 1896. The grand total for the United Kingdom for last year was made up of 684 steamers of 1,301,325 tons and only six sailing vessels of 2,569 tons. Included in these figures are 142 vessels of 312,549 tons built in the United Kingdom on foreign orders; an advance over the previous year, when, however, the great engineers' strike had a considerable effect on the output. The proportion of the world's shipbuilding put out by the United Kingdom during 1898 was 72.78 per cent., an improvement also over the previous year, but still considerably under the maximum figures of former years. The year 1898 was a record breaker in shipbuilding, the total for all countries, 1,233 vessels of 1,791,485 tons, being the greatest of recent years, and only approached by the total for 1890, which was 1,362 vessels of 1,646,809 tons. France took fourth place last year with forty-one vessels of 53,483 tons, and Italy next with twenty vessels of 26,806 tons. Norway was sixth, and Japan seventh with 22,412 tons, an increase in her case of nearly 100 per cent. over the preceding year. There

was a very considerable falling off in the tonnage built by British colonies, the total for 1898 being forty-three vessels of 9,586 tons, and for 1897, forty-eight vessels of 14,932 tons. The average tonnage of all vessels built during 1898 was 1,452 tons, which is in line with the decrease apparent since 1895. Of the steam vessels built during the year eight exceeded 10,000 tons, fourteen were between 7,000 and 10,000 tons, and eighty-five were between 4,000 and 7,000 tons. A division of vessels built during 1898, according to material used, showed these totals: Composite, seven vessels of 1,686 tons; wood, 250 vessels of 79,193 tons; iron, ninety-one vessels of 15,344 tons, and steel, 885 vessels of 1,695,262 tons.

A VERY interesting summary of the progress in shipbuilding and marine engineering during the past sixty years was made by Sir W. H. White, chief instructor of the British navy, in a paper recently read before the mechanical science section of the British Association. The distinguished engineer chose for the title of his paper, "Steam Navigation at High Speeds." Sir William White is of opinion that the increase in size of steam vessels will continue, though progress in sea speeds will be necessarily slow, depending upon various considerations, which include lightness of structural material, use of special fuels, increase in steam pressures and rates of revolution, accompanied by an increase in the number of propellers employed. In the time specified the length of steamships had increased 40 per cent, displacement had trebled, and speed had increased one-half. Progress, he said, had been due chiefly to these changes: Growth in dimensions and weights of ships and in engine power; engineering improvements, making practical use of high pressures, with consequent economy in fuel consumption, and reduction in weight of propelling machinery in proportion to power developed; structural improvements in material used and general arrangement, giving relatively lighter vessels and larger carrying power; modifications of form leading to diminished resistance, and economy of power expended in propulsion.

"Speed has been increased from 8 1-2 to 22 1-2 knots; the time on the voyage has been reduced to about 38 per cent of what it was in 1840. Ships have been more than trebled in length, about doubled in breadth, and increased tenfold in displacement. The number of passengers carried by a steamship has been increased from 100 to nearly 2,000. The engine power has been made forty times as great. The ratio of horse-power to the weight driven has been increased fourfold. The rate of coal consumption (measured per horse-power per hour) is now only about one-third what it was in 1840. To drive 2,000 tons weight across the Atlantic at a speed of 8 1-2 knots, about 550 tons of coal were then burnt; now to drive 20,000 tons across at 22 knots, about 3,000 tons of coal are burnt. With the low pressure of steam and heavy slow-moving paddle-engines of 1840, each ton weight of machinery, boilers produced only about two-horse power for continuous working at sea. With the modern twin-screw engines and high steam pressure, each ton weight of propelling apparatus produces from six to seven horse power."

The author had a word to say about the introduction of the water-tube boiler on a large scale. Differences of opinion prevailed as to the particular type of water-tube boiler which might be adopted, but the "weight of opinion" was distinctly in favor of some type of water-tube boiler in association with the high steam pressures now in use. Greater safety, quicker steam raising, and, above all, economy in weight, accompanied the water-tube boiler; though as to economy it did not appear probable that with coal as fuel water-tube boilers would surpass the cylindrical boilers now in use, and "skilled stoking" was necessary to keep water-tube boilers on an equality with cylindrical boilers in the matter of coal consumption. Sir W. H. White at the same time called attention to the fact that as more perfect mechanical appliances are introduced so more skilled and disciplined management is required in order that the full benefits may be attained. In the engine room this had been appreciated and why not in the boiler room? Our opinion on this point is, that while it may be possible with the aid of naval discipline to get such results on war vessels it will be a much more difficult matter to introduce engine-room methods in merchant marine stokeholds. Working conditions are such in the average stokehold that the best class of labor is not attracted to the work. As the demand for high intelligence, rather than mere strength, becomes greater and greater, inventive genius will develop mechanical aids which will make the steam generating plant more exact and economical in operation. In the mechanical stoker now in embryo for marine uses will probably be found the solution. Liquid fuel would, as the author points out, solve the difficulty, but it is very doubtful if supplies sufficient for merchant use will ever be available. In materials of construction Sir William White sees possibilities for further progress, and he is of the belief that the shipbuilder will obtain substantial aid from the metallurgist in the future.

CORRESPONDENCE DEPARTMENT.

[*Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced, if necessary to illustrate the subject, without cost to the writer.*

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

A Remarkable Newspaper Narrative.

Editor of Marine Engineering:

Noting the interest you take in mishaps to vessels, I send herewith a clipping from our local paper of a very remarkable breakdown at sea, which I believe will be of general interest:

"The steamship *Montucla,* of the Magellan Line, has just reached port, after experiencing a most remarkable and interesting series of casualties. The story, as we gather it from a cabin passenger, is substantially as follows:

"It appears that when in lat. 40 N., long. 86 W., one of the screw stay-bolts, which was occasionally used as a brake on the reversing engine, gave way without warning. This led to a collapse of the after horizontal tube-sheet of the donkey boiler, and at the same time allowed the reversing engine to run away with the air-pump links. In consequence of this combination of circumstances the vacuum escaped almost instantaneously into the high-pressure crank-pin brass. This caused the latter to swell with the increased tension, and suddenly brought the main engine to a standstill. Almost at the same instant the air-cock on the wing furnace of the starboard boiler became inflated, and in consequence partially filled up the spaces between the corrugations. Even the Mushet steel, of which the furnace crown was constructed, could not long stand the extra strain thus brought to bear, and with a deafening roar the furnace collapsed and drove the salinometer pot and three spare grate bars with terrific force through the thrust bearing, making a clean perforation from end to end. The steam thus liberated then found a vent into the sea through the runner of the circulating pump, and did no further damage.

"With commendable zeal the engineers set to work immediately to repair damages. A new screw-stay-bolt was first draw-filed up from a spare shaft-coupling, and after some difficulty was fitted in place. The collapsed furnace was then removed, and a spare section of funnel, which was fortunately at hand, was fitted in its place. At the same time the collapsed tube-sheet was cut out and retempered, while the bent and damaged flues were replaced by a few nickel steel condenser tubes. The furnace crown sheet was then secured in place by a rust joint. Having no rust convenient, however, an ingenious substitute was employed, composed of sulphur, ashes and iron filings, the latter being obtained by pulverizing one or two spare boiler zincs. The escaped vacuum was then forced out of the crank-pin brass by means of a 20-ton hydraulic jack, and the brass was thus reduced to its proper size. This freed the main engine, and it only remained to repair the thrust-bearing. After some consultation it was agreed to plug the hole with a patent boiler-tube-stopper, but after a few trials this was found ineffective, because the horseshoe rings were not prevented from jamming on the lignum-vitae of the stern bearing. Finally, however, the bearing pedestal was lashed in place by three turns of square sennit laid up from spare air-pump rods, and the hole was more effectively plugged by a phosphor bronze bolt sawn with a hack saw from a spare propeller hub.

"These repairs were completed in the surprisingly short time of 37 1-2 minutes, and proved in every way effective, the engines developing the surprisingly high duty of 107 I. H. P. per lb. of condensing water for the remainder of the trip.

"It is understood that the officials of the company propose to suitably reward the chief engineer and his assistants for the skill and resource which they manifested on this occasion." CHAPULTEPEC.

AMERICAN SOCIETY OF NAVAL ENGINEERS.—"We are in receipt of many inquiries as to to the propriety and prospects of retaining the individuality of the American Society of Naval Engineers," says the *Journal* of the society, "now that the Personnel Bill has removed the name of Engineer Corps from the Navy Lists. The inquiries are not unnatural, but imply a misunderstanding of the spirit of the Bill. The Naval Engineer not only exists in the American Navy to-day as distinctly as he ever did, but the whole tenor of the Personnel Bill is to expand the number of engineers by the addition of all the Line Officers. Eventually this must be the result, as essentially the modern naval officer must be an engineer. There is no diminution of interest in engineering by those who formerly were in the Engineer Corps, and there is no reason for imagining any waning of this interest. There is no profession which is advancing more rapidly, scientifically, than naval engineering. Its work approaches that of an exact science, in which generalities are replaced by positive facts and unimpeachable data. Continuous observation and study is the price of the retention of a position even in the rear ranks of the on marching body of the profession, and this society, with its name and purpose unchanged, will continue to hold a most important place in the engineering world."

S. S. INCHKEITH.—A new steamer, the *Inchkeith,* built on the East Coast of England for Liverpool owners, has been fitted with a set of Mudd's patent 5-crank, quadruple expansion engines, and the necessary equipments, the same as those originally fitted in the S.S. *Inchmona,* which, at the time, attracted widespread attention in the engineering world. It has been claimed for the *Inchmona* that the coal consumption during her entire period of service, since she was sent to sea in May, 1896, has not exceeded on the average more than 1.15 lbs. per indicated horse power per hour. The new steamship *Inchkeith* is of the following dimensions: Length, 348 ft.; beam, 47 ft., and depth, 28 ft. 1 in. On a draught of 22 ft. 5 in. her dead weight capacity is 5,600 tons. The vessel is of the spar deck type and has a total capacity for water ballast of 1,287 tons. The engines of the *Inchkeith* have cylinders, 17 in., 24 in., 34 in. and (2) 42 in. dia. with 42 in. stroke. The boilers, which are of the Scotch type built from Mudd designs, are calculated for a working pressure of 260 lbs. per sq. in., and are fitted to work with Ellis & Eaves induced draft. A very complete equipment of auxiliaries has been installed.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS.

BY DR. WILLIAM FREDERICK DURAND.

§ 2. MATERIALS AND CONSTRUCTION.

[1] Materials.

Open hearth mild steel[1] is used almost universally as the material for boiler construction, and in standard practice is used exclusively for shells, drums, heads, furnaces, combustion chambers and braces. Both steel and wrought iron are used for tubes, though solid drawn steel tubes may be considered as the better representing advanced engineering practice. Wrought iron is also used to some extent for rivets, though in the best modern practice steel rivets are preferred.

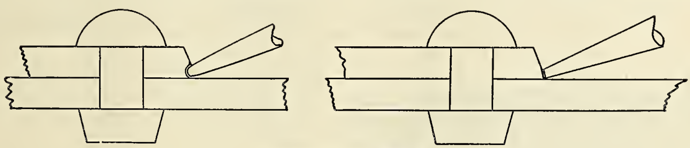
[2] Joints.

The various plates of a boiler are fastened together by riveted joints. These are of several varieties, as shown in the article on "Riveted Joints" published in the last issue of Marine Engineering, to which reference should be made.

The holes in the plates are either drilled or punched. The former method is much the better. In the operation of punching, a thin skin of metal about the hole is so severely strained that its strength, and especially its ductility and toughness, are reduced far below what they are in the remainder of the plate. This is not the case with the operation of drilling, or, at least, not to anything like the same extent. Drilled holes may also be located more accurately than punched holes, and thus with the former the parts of a riveted joint may be more perfectly fitted than with the latter. The operation of drilling leaves, however, a sharp edge, which should be removed by a reamer in order to avoid any tendency to cut the rivet. In spite of the greater cost of drilled holes they are now generally accepted as the best for all high-class work, and in many specifications no holes are allowed to be punched.

Riveting is either by hand or by machine; usually hydraulic. The latter gives much the better result, and is preferred where the machine can be made available. In many cases the construction is such that the jaws of the machine cannot be brought to bear on the joint, and in consequence hand riveting must be employed.

After being riveted the joints are calked to insure tightness against leakage. This operation consists in beating down the edges of the metal against the face of the opposite plate by means of special pneumatic driven or hand tools, as shown here in Fig. 1. These are known as *calking* tools, and are of two types, square and round nosed, as shown in the figures. The latter form is usually employed in modern practice.

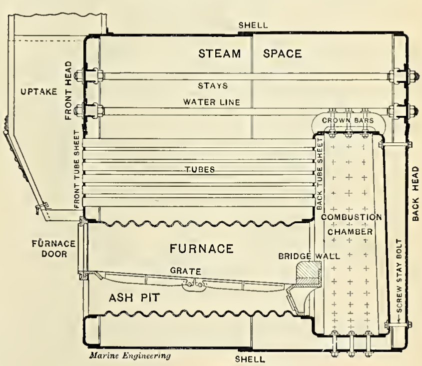


CALKING TOOLS.—FIG. 1.

[3] Construction of Fire Tube Boilers.

We will now consider the chief features of the the construction of a Scotch boiler. This will, at the same time, sufficiently illustrate the operations involved in the construction of other types of fire-tube boilers.[2]

In the best practice the longitudinal joints are double butt-strapped and triple-riveted in order to give to the boiler in this direction the highest possible proportion of the strength of the plate itself. The circumferential joints, those which run around the shell, are lapped and double or triple riveted. So far as internal pressure is concerned the boiler is twice as strong to resist rupture around the girth as lengthwise, so that a lapped circumferential or girth joint is quite enough for strength alone, and it only remains to make it steam and water tight and to insure the necessary stiffness of the boiler as a whole. Single-ended boilers are usually made with two courses of plates, as in Fig. 2. Double-ended boilers are usually made with three courses. Each course consists of two or three sheets, varying with the diameter of the boiler. The heads are flanged, as shown in Fig. 2, and thus secured by riveting to the shell. In some cases the shell has been flanged instead of the head, but such form of construction is rare. The head flanges are sometimes turned out and sometimes in, as shown by the figure. Where machine riveting is to be used they must be turned



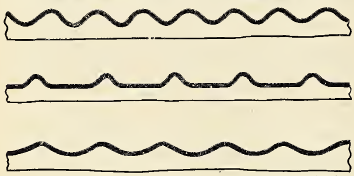
SCOTCH BOILER.—FIG. 2.

[1] See issues of April, 1899, page 44, and May, 1899, page 47.

[2] See July, 1899, issue, page 37.

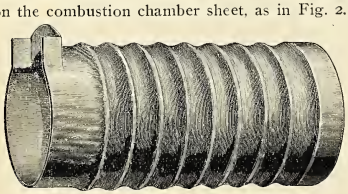
out in order to allow the riveter to do its work. The back head is made usually in two pieces, with double or triple-riveted lap joints. The front head is made in two or three pieces, according to size of boiler, usually with double-riveted lap joints. When in three parts they are called the upper head sheet, the front tube sheet and the front furnace sheet.

The furnaces, as shown, are corrugated in order to



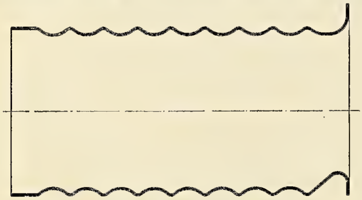
. FURNACE CORRUGATION.—FIG. 3.

give greater strength and elasticity. There are three styles of corrugation in common use, as shown in Fig. 3. The furnaces are riveted to flanges formed on the front furnace sheet, and are connected by flanging to the sheets of the combustion chamber. Several different modes of connection are in use for this purpose. In one the furnace end is left plain and the flange is all on the combustion chamber sheet, as in Fig. 2. In



FLANGED FURNACE.—FIG. 4.

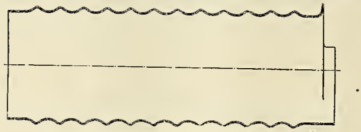
another the combustion chamber sheets are left plain and the flange is on the furnace, as shown in Fig. 4. In some forms provision is made for removal and renewal without disturbing the furnace head sheets. Thus, in Fig. 2, the diameter at the front is the same as or slightly larger than that at the outside of the corrugations, and so the furnace may be withdrawn



REMOVABLE FURNACE.—FIG. 5.

through the opening in the front sheet. In other forms of connection, where the furnace is flanged, especial provision must be made for removal, as shown in Fig. 5. Here the back end of the furnace is necked in on the bottom and sides, and a flange is thus obtained which only extends outside the outer diameter of the corrugation at the top. This flange serves to attach the furnace to the combustion chamber, and on cutting the joint loose the furnace may be taken straight to the front until the upper flange strikes the front sheet, and then swung upward and out of the front opening, as may be readily seen.

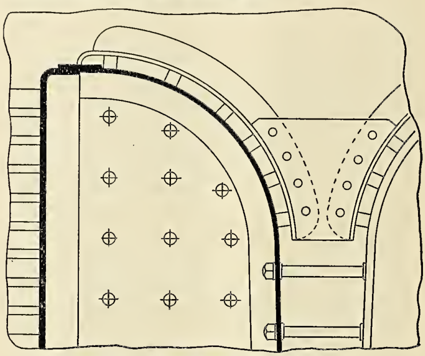
In some cases where it is difficult to obtain the necessary room on the front head for the greater diameter of the outside of the corrugation, or where, for other reasons, it is not considered preferable to have the furnaces removable without disturbing the front sheet, the furnace end at the front runs out on the smaller



NON-REMOVABLE FURNACE.—FIG. 6.

diameter, as shown in Fig. 6. Some one of the forms favoring easy removal may be recommended as preferable in all ordinary cases.

The combustion chamber, as shown, is built up of steel plates flanged and riveted together. The details of the construction vary somewhat with the form of furnace attachment adopted, with the size of the boiler, and with the choice of the designer. The front plate is known as the *back tube sheet.* The top of the combustion chamber is sometimes flat, as in Fig. 2, and sometimes rounded up, as in Fig. 7.



ROUNDED TOP COMBUSTION CHAMBER.—FIG. 7.

The tubes are secured into the tube sheets by "expanding," and "beading" or turning over at the back or at both the back and front ends. See Figs. 8, 9, 10. Tubes are expanded by means of a tool as shown in Fig. 11 representing the Dudgeon expander. The tool is introduced into the mouth of the tube and the small steel rolls are forced out by means of the tapering steel mandrel on which they rest. The mandrel is then turned around, and this by means of the frictional contact with the rolls causes them to turn also and thus to roll around on the inner surface of the tube, carrying the whole tool slowly round and round. The mandrel is continually forced in and thus the rolls are

forced outward against the tube. The action is thus a rolling of the tube out against the tube sheet, and in this way the joint is made thoroughly tight.

The Prosser expander which was generally employed in former years is now but rarely used. It consists, as shown in Fig. 12, of a hollow tapering plug divided up into separate elements or sections which are held together by a steel band. These are forced outward against the inner surface of the tube by driving a taper

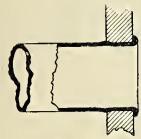


FIG. 8.

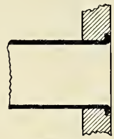
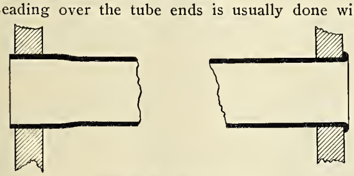


FIG. 10.

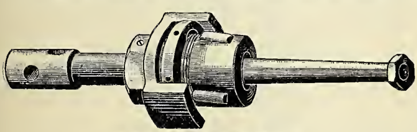
mandrel into the hollow between the elements. The action of the expander is thus to force the metal of the tube out against the edges of the sheet in a form of circular ridge as shown in Fig. 8.

Beading over the tube ends is usually done with a



FIRE-TUBE ENDS.—FIG. 9.

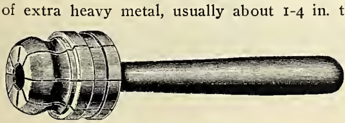
tool as shown in Fig. 13, and the result is as shown in Figs. 8, 9, 10. In some cases the tube sheet is recessed out for the beaded end of the tube, as shown in Fig. 10. The front ends of the tubes, as shown in Fig. 9, are usually swelled slightly larger than the rear ends to facilitate removal. The thickness of the metal of



ROLLER EXPANDER.—FIG. 11.

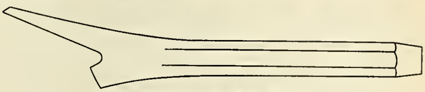
plain boiler tubes is usually from 8 to 12 wire gauge, or from about .17 to .10 in.

In addition to the plain tubes fitted as before described, stay-tubes are also frequently fitted. These are of extra heavy metal, usually about 1-4 in. thick-



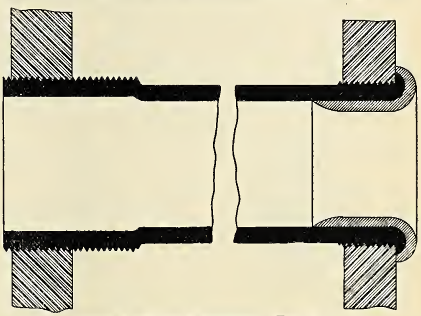
PROSSER EXPANDER.—FIG. 12.

ness, and specially fitted to the tube sheets by screw joints as shown in Fig. 14. These tubes act as stays between the tube sheets. Further reference to this point will be found under the head of *bracing*. When stay tubes are fitted, it is customary to bead over only the back ends of the plain tubes, as in Fig. 9. Not infrequently, however, no stay tubes are fitted, and in such case the plain tubes must be beaded over on both ends in order that they may securely support the tube sheets. Instead of the ordinary form of boiler tube, the *Serve* tube of cross-section as shown in Fig. 15 is frequently fitted. The ribs of metal reach down into the column of hot gas moving through the tube and



BEADING TOOL—FIG. 13.

furnish additional surface to absorb the heat and help it through into the water. The surface on the fire side is thus much greater than the surface on the water side,

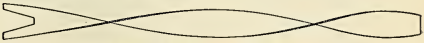


STAY TUBE WITH FERRULE.—FIG. 14.

while with the plain tube it is somewhat less. Such tubes usually show an increased evaporation per square foot of surface measured on the water side, of from 15

SECTION OF SERVE TUBE—FIG. 15.

to 20 per cent. Their increased weight, however, offsets in a measure this increase of evaporative efficiency per square foot of surface.



SPIRAL RETARDER.—FIG. 16.

Reference may also be made at this point to the use of *retarders* in boiler tubes. These are long twisted strips of thin sheet steel as shown in Fig. 16. They are simply laid in the tubes and serve to give the gases

more or less rotary motion and to assist in throwing them outward against the surface of the tube. With forced draft and high rates of combustion the use of retarders has been accompanied with a marked increase of economy. In some cases both Serve tubes and retarders have been fitted, but the special advantages of the combination may be called in question.

As a measure of protection for the back ends of tubes under forced draft, cast iron ferrules are sometimes fitted. Fig. 14 shows the so called *Admiralty* ferrule in place in a stay tube.

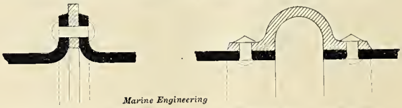
Bracing.—We must now consider the bracing needed to make the boiler perfectly secure and safe under the pressures to which the various parts will be subjected. The general principles to be kept in mind are as follows: (*a*) Cylindrical surface subjected to pressure on the concave side are not helped by bracing. They must be made sufficiently strong by giving to the material a suitable thickness. (*b*) Cylindrical surfaces subjected to pressure on the convex side may be stayed like a flat surface, or they may be stiffened by ribs running around them in planes at right angles to the axis. (*c*) Flat surfaces will support themselves if their area is sufficiently small in relation to their thickness and to the load per square inch, and it follows that large, flat surfaces must be subdivided into parts of such size that they may thus become self-supporting.

As an illustration of (*b*), furnaces were formerly strengthened in this way, and the long favorite Adamson ring as shown in Fig. 17 or the Bowling ring as shown in Fig. 18 may be taken as good illustrations of this mode of adding support to cylindrical surfaces loaded on the convex side. The present corrugated furnace, especially the Purves type as shown in Fig. 3, may be considered as a further illustration of the same principle. In modern marine boilers, aside from the furnaces, this mode of support is chiefly used to stiffen the bottom of single combustion chambers where screw stay bolts could not be readily fitted, and also in some cases the curved tops of combustion chambers. See Fig. 7.

Coming next to flat surfaces as referred to under (*c*) the necessary subdivision is provided by the fitting of braces connecting the part to be supported to some point where the support can be provided, or by connecting together two surfaces urged by the steam in opposite directions, as for example the two opposite heads of a boiler as shown in Fig. 2. Occasionally also flat surfaces are aided by attaching to them stiffening ribs of angle or tee bar, as on the front tube sheet between the nests of tubes, or between the tubes and the shell.

Plates which are subjected to the direct action of the fire, as in the furnaces and combustion chambers, are made relatively thin. This is done because a thin plate transmits heat better than a thick one, and is subjected to less severe internal stresses due to the difference in temperature of its two faces. The thinner the plate, however, the less the area which will be self supporting. Hence the braces for thin flat plates are relatively small and closely spaced, while those for thick plates are larger and spaced at a greater interval.

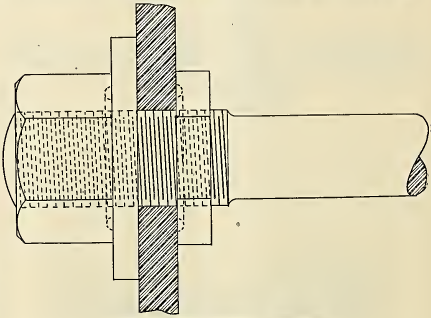
The main head braces are secured as shown in Fig. 19. A washer is fitted on the outside to increase the supported area, and a nut is fitted both inside and outside so that the joint may readily be made tight, and that the brace may, if needed, act as a strut against pressure from without as well as a tie against pressure from within. In some cases a relatively thin plate is supported by a brace connecting it to a thicker or perhaps to a doubled plate, or to a place not requiring support itself, but which furnishes a convenient point for carrying the load. In such case the attachment to



ADAMSON RING.—FIG. 17. BOWLING RING.—FIG. 18.

the thin plate is often made as shown in Fig. 20 in order the better to subdivide and distribute the support. In double ended boilers, certain parts of the head, as for example those between the furnaces, are supported by braces running obliquely back to the shell and attached as shown in Fig. 21. It often thus happens that braces must run at a slight obliquity in order to connect the parts to be supported with convenient points of support. Other instances are often found in the braces connecting parts of the back tube sheet below or between the tubes to the boiler head. In all such cases, wedge shaped washers as shown in Fig. 22 must be fitted under the nuts in order to get a good bearing between the nut and the shell.

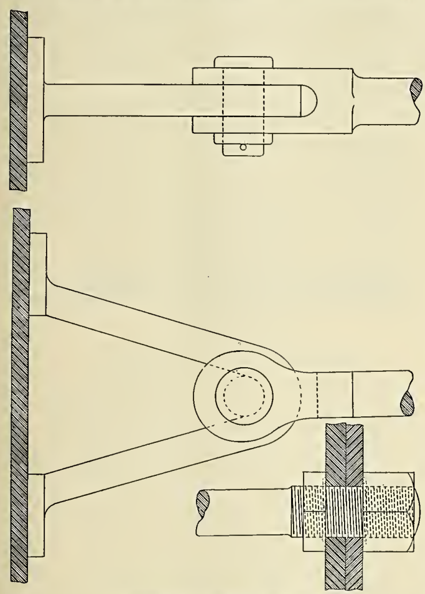
The braces connecting the relatively thin plates of the combustion chamber to the back head and shell of the boiler and to each other, are fitted by screwing them through into both plates as shown in Fig. 23. The ends are sometimes riveted over and sometimes fitted with nuts. In some cases they are left threaded the entire length, in others the threads are raised on the ends, as in the main head braces. The latter practice is much to be preferred. These braces are commonly known as



MAIN HEAD BRACE END.—FIG. 19.

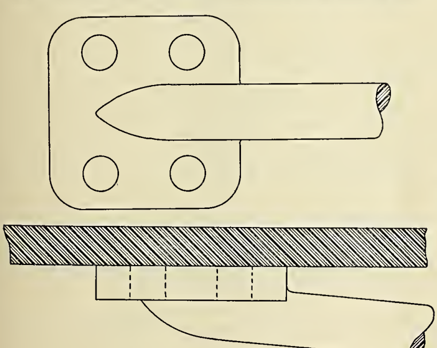
"screw stays," or "screw stay bolts." This mode of fitting enables the screw stay bolt to act both as strut and as tie, or to resist pressure in both directions. In some cases the older form of "socket bolt," as illustrated in Fig. 25, is still fitted. In such case the head is riveted and the part of the bolt between the plates is provided with a hollow "socket." This acts as a strut and as a

protection to the bolt proper. In modern approved practice screw stay bolts are either hollow or are drilled in at each end, see Fig. 25, to a point well beyond the inner face of the supported plate. The expansion and



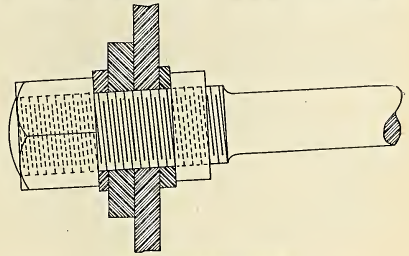
FORKED END BRACE.—FIG. 20.

contraction of such parts of the boiler often have the effect of bending these bolts back and forth, and they may thus in time become broken off, the break naturally occurring near the thicker of the two sheets where



FLANGE END BRACE.—FIG. 21.

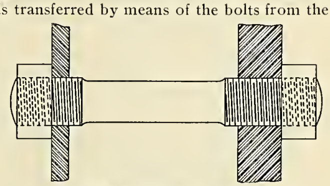
the bolt is held more rigidly. If this should occur, or if the bolt should become badly corroded or pitted, especially near the plate, warning will be given of the fact by the escape of water or steam, and proper means may be taken for replacing the bolt. In this way timely warning may be given of a condition of affairs, which if allowed to go unnoted, might result in



OBLIQUE BRACE END.—FIG. 22.

a collapse of the plate, or in a disastrous explosion of the boiler as a whole.

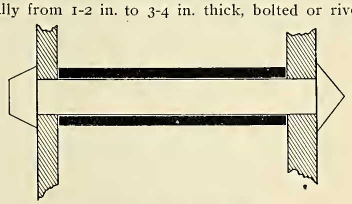
For the support of the top of the combustion chamber, girders or cross-bars are used, see Fig. 26. The load is transferred by means of the bolts from the com-



SCREW STAY BOLT.—FIG. 23.

bustion chamber plate to the girder, while the latter is supported by the edges of the vertical plates forming the front and back of the chamber.

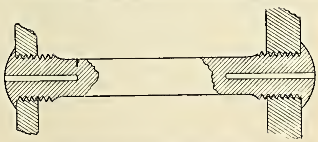
These girders are made of two pieces of steel plate, usually from 1-2 in. to 3-4 in. thick, bolted or riveted



SOCKET BOLT.—FIG. 24.

together with distance pieces between so that the bolts which take the load from the flat plate may pass up between them as shown in the figure.

The combustion chamber is sometimes secured to

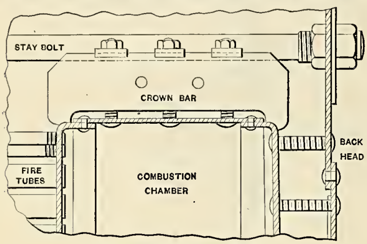


IMPROVED SCREW STAY.—FIG. 25.

the back head of the boiler, or in double ended boilers the two combustion chambers are secured together by

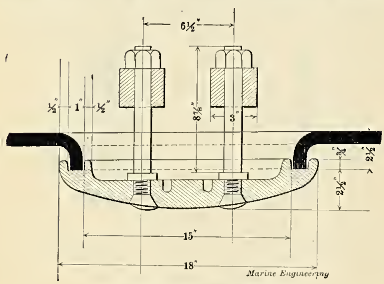
plate braces fitted as shown in Fig. 7. Such are usually called *gusset* braces.

In the general internal arrangement of the tubes, furnaces and combustion chambers, care must be taken to



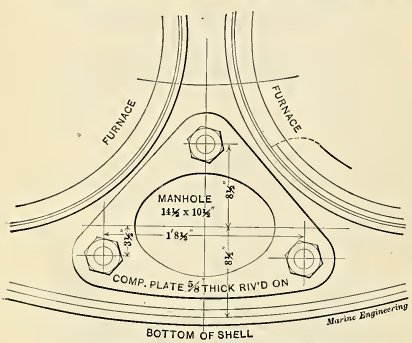
CROWN BAR --FIG. 26.

allow, as far as possible, a ready examination of the various parts. In good modern practice a space of



FLANGED MANHOLE.—FIG. 27.

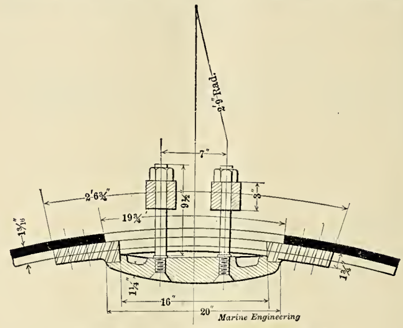
from 10 to 12 inches is left between the nests of tubes and between the tubes and shell, so as to allow the pas-



MANHOLE BELOW FURNACES.—FIG. 28.

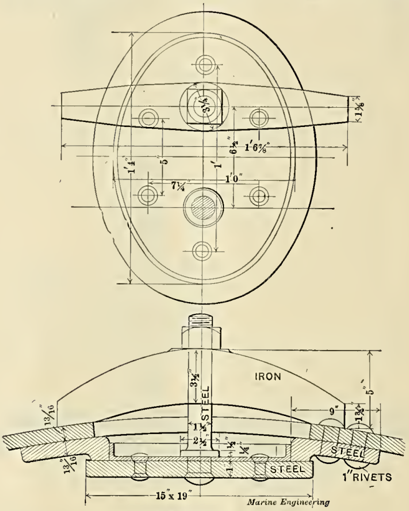
sage of a man from the steam space down through these spaces to the furnaces.

Manholes and Covers.— For the purpose of entering, examining and cleaning the interior of a boiler, man or hand holes are cut in the head or shell. These are then covered by *manhole covers, plates* or *doors,* as they are variously called. These are secured by bolts and dogs, as shown in Figs. 27-30. The usual size of a manhole is 11 by 15 inches, which are the dimensions required by the U. S. rules. It is of oval or elliptical



CAST STEEL RING AND DOOR.—FIG. 29.

shape, so that the cover with its lip extending over the edge may be gotten in and out without difficulty. The joint is made on the inside in order that the pressure may tend to keep the joint tight. A hand-hole is entirely similar in shape and fitting, and is simply smaller in size. In order to provide local strength and stiff-



MANHOLE DETAILS.—FIG. 30.

ness and to help support the load which comes on the feet of the dog, and also when the hole is cut in the shell to restore in some measure the metal taken out, a reinforce ring of metal is fitted about the hole. Such a ring of cast steel for a hole in the shell is shown in

Fig. 29. The inner face is plane, so that the joint with the cover is readily made. In order that the removal of the metal may affect as little as possible the strength of the shell, the longer axis of the hole should run around the boiler rather than lengthwise. For holes in the head of a boiler the metal is often flanged inward as shown in Fig. 27, the joint being made against the dressed edge of the ring. Where a manhole or handhole comes close to the through braces, as, for example, below the furnaces, the reinforce plate is cut in a shape approximating a triangle, as shown in Fig. 28. At each angle or corner the plate is of sufficient width to let the threaded end of the brace come through, and the outside nut is then jammed down on the ring. For heavy pressure the fitting illustrated in Fig. 30 may be recommended. The reinforce ring is of flanged steel, and the cover of steel plate also, somewhat thicker than the metal of the shell. An angle iron, as shown, is riveted to the cover, making a neat fit within the reinforce ring, and keeping the plate accurately to its seat.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—What is meant by the statement about an engine that "she will run on 20 lbs. of steam per horse power per hour," and how is this determined?

OAKLAND.

A.—One horse-power means the doing of 33,000 foot pounds of work in one minute. This means the work required to raise 33,000 pounds, 1 foot high, or 1 pound 33,000 feet, or 33 pounds 1,000 feet, or 100 pounds 330 feet, or any other combination of weight and distance, which will make 33,000 by their product, or more generally, any combination of a force overcome through a certain distance such that the product of the force measured in pounds multiplied by the distance measured in feet shall be 33,000. Now, if an engine performs this amount of work every minute for one hour it is said to give one horse-power per hour, or one horse-power hour of work. Similarly if an engine develops 200 horse-power for one hour, it does 200 horse-power hours of work.

Now the engine, in order to do this work, has to be furnished with steam or rather with the heat which the steam carries. We must remember that it is the heat which the engine really uses, and the water or steam is only a carrier for it.

The steam used per horse-power per hour or per horse-power hour means then simply the total steam which the engine requires per hour, divided by the horse-power developed, or the steam which each horse-power may be supposed to take.

For good triple expansion condensing marine engines, this will be not far from 15 pounds. For compound-condensing engines 18 to 20 pounds will be a fair figure. For single condensing engines the amount will rise to 25 pounds or over, while for simple non-condensing engines the amount required will be from 30 to 40 pounds or over.

The determination of this amount requires a regular engine and boiler test, in which the amount of feed water required is measured for a considerable period of time, say 8 or 10 hours, while at the same time the power developed is determined from indicator cards taken at frequent intervals, say every 15 to 30 minutes throughout the period of test.

Q.—In fitting out a new steamer I have decided to place a generating set on an artificial foundation to get rid of the unpleasant vibrations which the generating set when running usually sets up in a vessel. The set is a direct connected one and will be placed on the middle platform. The intention is to place the machine on a pedestal 24 in. high of 1-4 in. plate and to fill this with a grout of gravel and cement. In this case the extra weight is not a consideration. What is your idea of the matter?

W. L.

A.—The effect of this style of foundation on ship vibration is a matter difficult to predict in an abstract case. The vibrations depend on the unbalanced forces developed, on the location of the machine and the strength of the ships in its neighborhood, and on the relation between the revolutions of the dynamo and the natural period of vibration of the structure of the ship on which the machine rests.

The effect of a grouted foundation will be two-fold: 1. It will absorb in slight degree the vibratory influences, less as the foundation is more solid and rigid, and more as it is less firmly bound together.

2. Due to its own weight it will considerably increase the natural period of vibration of the platform, and thus possibly remove it from the likelihood of sympathetic vibration in step with the dynamo.

It may result from these effects that the vibrations will be considerably less than if the machine were placed directly on the floor plates, but if such should be the case it would seem more likely to be due to the latter rather than to the former of the effects noted above. It does not seem likely that merely as a damper or absorber of vibratory influences a grout foundation such as you refer to would be of much avail.

Q.—Which will travel the faster, and why, a ship being towed by a tow-boat, or the same ship fitted up with the same power that is in the tow-boat?

C. L. N.

A.—The ship alone will travel faster than the tugboat with the ship. The reason for this may be seen by working out an example.

Suppose that the tug's engine develops 1,000 I. H. P. Now, due to the necessities of tugboat design, the propeller is necessarily rather small to absorb this power at the ordinary towing speed, except at a high value of the slip. That is, when towing at an ordinary speed of say 8 miles, the slip of the propeller is large, perhaps 40 or 45 per cent or more. This is so well known that no further consideration of the point is necessary. As a consequence the propeller efficiency will be rather poor, and the *effective horse power* (what is left after taking away the loss by friction in the engines and the loss by the propeller) will be probably not more than about 450 H. P. This is the power, in other words, which is directly used in pushing the tug and pulling the ship. We will suppose that 1-5 of it goes for the tug and 4-5 for the ship. Then the latter amount is 360 H. P., and this we remember is the actual net amount required to pull the ship at a speed of 8 miles.

If, now, the machinery were fitted directly to the ship, the propeller could be better designed for its work, and its efficiency would be correspondingly higher. We may fairly assume in such case that the effective horse power would be say 55 per cent of the I. H. P. This means that the necessary I. H. P. to give 360 E. H. P. will be 360 ÷ .55, or about 650.

It thus appears that 650 I. H. P. properly fitted in the ship will give a speed of 8 miles, while, 1,000 I. H. P. are required for the same speed when the ship is towed by the tug. With the 1,000 I. H. P. applied in the ship with the same efficiency the speed would be raised to about 9 1-4 miles.

The gain is thus seen to be twofold:

(1) A gain due to the fact that with the ship alone there is less to be moved and less resistance to be overcome than with the ship and tug together.

(2) A gain due to the better efficiency which may usually be expected from the machinery fitted in the ship than in the tug at the towing speed.

The figures taken above are intended, of course, to illustrate a single supposed case, and while actually the gain might be greater or less than in the case taken, the principles would remain the same.

It is reported that the American liner *Paris* sustained severe structural damage by stranding on the Manacle Rocks.

ENGINEERS' DICTIONARY.—XX.

Governor—A device for controlling the revolutions of a steam engine and preventing racing when the propeller is partially lifted out of the water by the pitching of the ship. The early types of marine engine were usually governed by hand at the throttle, which was commonly of the "butterfly" variety, though occasionally automatic means of moving the valve were employed. With modern multiple expansion engines it is impossible to satisfactorily control the revolutions by the throttle. With such engines the control must come from the slide valve gear, the links of which may be linked up more or less as required when the propeller is uncovered, and linked out again as it is submerged. Where no automatic governor is fitted, this must be done by hand control of the reversing gear. The modern automatic governor is intended to take the place of this hand control.

There are two modes of actuating marine governors. (1) By utilizing the varying pressure under the stern of the ship. (2) By utilizing a variation in the revolutions from the regular speed. In the first type a pipe is run from the outside water at the stern to some form of pressure chamber near the engine, within which is a flexible diaphragm held in position by a spring or other equivalent means. The water being admitted to this pipe, the air within is compressed according to the head of water over the outer end. The apparatus is so adjusted that at normal draft the diaphragm is in equilibrium between the two forces, due to the water pressure on one side and the spring on the other. A change in the depth of water will cause a variation in the pressure which will be transmitted through the air and thus destroy the equilibrium, throwing the diaphragm in one direction or the other. This may be made to actuate a steam valve and thus through an auxiliary steam piston control the reversing lever and thence the links. In former times this type of gear was sometimes made sufficiently large to actuate the steam throttle valve directly, or sometimes a like valve in the exhaust pipe.

The other type of governor is found in various forms. In many of them use is made of the centrifugal force of revolving balls or weights somewhat as in the ordinary stationary governor. Through the force thus available a small valve is operated, thus leading through a series of stops to the control of the reverse lever or other part which it is desired to operate. Again in other forms a revolving fan or propeller working in a box filled with liquid maintains the apparatus in a certain condition at a certain speed. With a sudden change of speed, a corresponding change of resistance to the motion is met with, and this difference of force may be used to operate a small valve, and then, as before through the proper steps, the reversing lever is controlled. In another form a pump continually forces air into a chamber from which it escapes through a cock whose opening may be regulated at will. For a given size of outlet and speed of pump the pressure will rise until finally as much escapes as enters and the pressure remains constant. If the speed changes, however, the pressure will change correspondingly, and this difference of pressure will give a force which may be used as already explained.

All forms of marine governor are somewhat slow in controlling the variations of speed. The ideal governor would anticipate the motion and close down or open up just in advance of the rise or fall of the stern. Instead of this it opens and closes only after the stern has risen or fallen, and after the variation of speed has become more or less pronounced. It is usually considered good practice, however, to fit some form of automatic governor, at least as an emergency control, so as to prevent an excessive increase of revolutions from any cause whatever, as, for example, the breaking of the shaft or other like accident. For this reason those forms of governor which depend on a change of speed are to be preferred, and are usually fitted in modern practice.

Graphite—One of the forms of carbon. It is the substance commonly called *black-lead.* It is much used in modern engineering practice as a lubricant, either alone or in combination with a heavy oil. It is also used with oil or grease in the form of a putty for making up screwed and faced steam joints, and for coating sheet packing used in making bonnet and cover joints of various kinds. It is also used as a constituent of many forms of fibrous packing, both for steam and water joints, and for stuffing-boxes.

Grate—That part of a furnace on which the burning fuel is supported. The grate is formed of grate bars of various forms with spaces in and between them, the whole forming a support through which the air may enter and pass upward through the fuel, and through which also the ashes may fall to the ash-pit below. The area of the air passages through the grate is usually about one-half of the grate surface, though this as well as various other features of the grate depend on the nature of the fuel to be burned.

Grate Bars—The bars which compose a *grate.* They are of two general types, *stationary* and *shaking.* In Fig. 79 is shown a cut of an ordinary cast iron stationary grate bar. Shaking grates or shaking grate

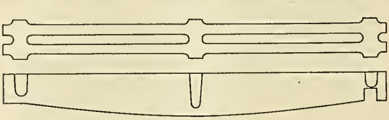


Fig. 79.

bars are found in a great variety of forms, the general purpose of all being the provision of means whereby the shaking of the grate will break up the fire, rattle out the ash and clinker, and give the air free access to the burning coal.

Grate-Surface—The surface or area of the grate. This is one of the fundamental characteristics of a boiler, for together with the rate of combustion per square foot of grate it determines the total amount of coal which can be burned.

Guard—A general term relating to some portion of a machine or appliance intended to guard or protect some other portion, or to control or limit its motion. See for example the air-pump-valve-guard under *Air pump*, Fig. 2.

NEW PUBLICATIONS.

Theoretical Naval Architecture. A text book by E. L. Attwood, Assistant Constructor Royal Navy. First Edition 1899. Longmans, Green & Co., London and New York. Size 5 by 7 1-2. Pages 292. With 114 diagrams, cloth, $2.50.

According to the author's preface this book has been prepared in order to provide students and draughtsmen engaged in Shipbuilders' and Naval Architects' drawing offices with a text book which should explain the calculations which continually have to be performed. It is intended also that the work, and more especially its later portions, shall serve as a text book for the theoretical portion of the examinations of the British Science and Art Department in Naval Architecture.

The book is written throughout in a simple and elementary style, and the subject matter proper seems to be well selected, and the demonstrations are given in plain and simple language.

In the development of the subject the author has avoided the use of the calculus, and as a necessary consequence has seriously handicapped himself in its presentation, and in the proof of many of the most familiar operations. To some extent this lack is made up by an appendix, where a few of the omitted proofs are given in more general form by the aid of the higher mathematics.

It is perhaps to be regretted that the author felt compelled to include with his proper subject matter a certain amount of elementary geometry, trigonometry, and mechanics. In a text book on Naval Architecture the policy of devoting space to matter of this character may be questioned.

A special feature of the book is found in the examples given in connection with the various chapters. Many of these are drawn from actual office practice, and should be of especial value to those working by themselves.

The field covered by the subject matter, as a whole includes the operations and problems usually arising in statical naval architecture, with short chapters on the strength of a ship and on resistance and power. These latter chapters are the least satisfactory in the book. They are too incomplete and fragmentary to be of real value to the student of the subject, either from the theoretical or practical point of view. All reference to propulsion and to the propeller is omitted.

From the standpoint taken by the author and with the limitations under which he has chosen to work, the earlier chapters especially seem to furnish an excellent presentation of the subject. The task is a difficult one of dealing with such a subject in which the actual mental attitude must necessarily be one involving the conceptions of higher mathematics, but without using their nomenclature or methods of analysis.

The book should be of great aid to those not familiar with higher mathematics, and who wish to study the elementary theory of ship computations, but in the minds of all true students it must necessarily leave a desire for the greater fulness of treatment and generality of explanation which can only be provided by the aid of advanced mathematics. Such is doubtless the expectation and hope of the author, and under his self imposed limitations he has succeeded in providing an extremely interesting and valuable work for those interested in the subject.

A Practical Course in Mechanical Drawing. By William Fox, M.E., and Charles W. Thomas, M.E. First Edition, 1899. D. Van Nostrand Co., 23 Murray St., New York. Size, 5 by 8 1-2. Pages 98, with numerous illustrations. Cloth, $1.25.

According to the authors, both of whom are members of the faculty of the College of the City of New York, the object of this work is to provide a simple, practical course of progressive lessons in mechanical drawing, particularly adapted to the needs of high schools, schools of apprentices and young mechanics. The subject is a difficult one to present, and it is to be doubted if justice can be done to it in a volume of this size. The book proper consists of 32 exercises, several of which are devoted to the proper uses and handling of drawing instruments, and the remainder to concrete examples instead of an abstract and general presentation of the subject. With one or two exceptions these exercises are unusually good and make the book, as a whole, rather better than the average presentation of the subject. The book is, however, open to criticism in several particulars. The introduction seems to be rather beyond the average beginner, and the method of explaining the elementary principles of projection drawing (that of placing the object within a glass box and tracing on its panes the views of different faces) seems scarcely adequate. The proper relative positions of the different views of an object, according to the principles of projection, could have been given more prominence and explained more fully, since neglect in this particular, in practice, frequently leads to expensive "shop mistakes." Among other things which could well have been more extensively treated is the subject of drawing to scale. This is often one of the most difficult points for a beginner to master. The chapter on lettering might lead to artistic effects, but is not to be commended from a work-a-day standpoint. With two exceptions the examples of freehand lettering given are amateurish, and would not be passed in any draughting room where lettering is employed to convey instructions and not to produce a pleasing "picture." This is a common fault with books of this class and with young draughtsmen; it impairs the commercial value of both. The same criticism applies to the drawings throughout the book, few of which are even passably good, and nearly all are reduced to so small a scale as to be difficult to read. An excellent feature, however, is the fine half tone reproductions of photographs showing how various instruments should be held when in use.

Recent Publications.

There are many persons engaged in marine work who would like to have a good working knowledge of guns and their mounts and fittings, and of projectiles such as are used in modern naval practice; and yet these persons have neither time nor inclination to undertake a study of the subject as set out in text books and scientific treatises. It is for the information of such, primarily, that the book entitled "Naval Gunnery" was written by Captain H. Garbett of the British Navy. A sub title gives the explanation that the work is a description and history of the fighting equipment of a man-of-war, and it is dedicated by the author "to the

largely increasing members of the General Public who are interesting themselves in naval matters." On this side of the Atlantic the number of this class has increased very greatly since the breaking out of the late war. As the book is not intended for experts, it is written in a pleasant, discursive style, and yet in no place is it trivial. It is free from abstruse technicalities and mathematical demonstrations, so that the reader can go right ahead and absorb exact information with the minimum of mental effort. The history of the heavy cannon is written, from the smooth bore muzzle loading 68-pounder down to the modern naval weapon of over 100 tons, and in smaller guns from the 32 pounder to the 6 in. rapid firer of to-day. The chapters relating to modern weapons describe British practice chiefly, and while the special types of other nations are not exploited the reader will obtain a sound elementary knowledge of the principles involved. Naval guns everywhere are built with the same object in view—the maximum of destructive capability with the minimum of weight, bulk and expense, and a general knowledge of the subject can readily be supplemented by a special knowledge of the practice of our own or any other nation obtained from other sources. Some of the details treated in different chapters are: Breech loading rifles; rapid fire guns; magazines and loading arrangements; sights and firing arrangements; powder and high explosives; projectiles and fuses. To these are added chapters on the development of the modern battleship and its fighting organization. There are many fine engravings and drawings illustrating the text, and the book is of convenient size, and is printed in excellent style. It is one of the "Royal Navy Handbooks," published by George Bell Son's of London, and is sold in the United States by The Macmillan Co., 66 5th avenue, New York. The price is $1.50, cloth bound.

S. S. Winifredian.—The new steamer for the Liverpool-Boston route of the Leyland Line has been named the *Winifredian* and has been completed by Harland & Wolff at Belfast. This vessel is one of the modern type of steamships, with moderate speed, limited passenger accommodation, and large cargo carrying capacity. Her dimensions are: Length, 552 ft.; beam, 59 ft.; depth, 41 ft. Her dead weight carrying capacity is about 13,000 tons and load displacement about 20,000 tons. She is fitted with triple expansion engines, with cylinders 38 in., 56 in. and 94 in. dia. by 66 in. stroke, and of about 6,000 indicated horse power. She is a single screw vessel and has a sea speed of about 14 knots. Steam is generated in cylindrical fire-tube boilers, built for a pressure of 200 lbs. She has bunker capacity for about 1,100 tons of coal.

The new Allen Line steamer *Bavarian* for the North American trade ran its official trial trip on the Clyde recently, and a mean speed of 17.95 knots was attained. The new vessel is of the following dimensions: Length, 520 ft.; beam, 59 ft.; depth 43 ft., and gross tonnage, 10,200 tons. She will have accommodation for 500 passengers of all classes.

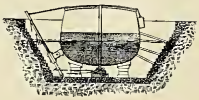
The former Guion liner *Alaska,* described in our issue of August, 1899, has been resold to Vickers, Sons & Maxim, engineers and shipbuilders at Barrow, for $95,000. She is reported to have been put to use as a floating hotel for workmen.

SELECTED PATENTS.

(Subscribers are notified that the publication of a patent specification in this column does not indicate editorial commendation or condemnation.)

631,154. Apparatus for applying anti-fouling coatings. G. D. Coleman, Bridgewater, Mass.

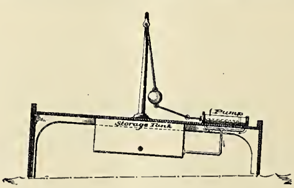
For rolling, smoothing and pressing the coating after it has been applied. Comprises a roller having a piv-



oted support, a traveling carriage on which the support is pivoted, and a guiding framework for the carriage.

631,178. Apparatus for utilizing wave-power. Thomas Redding, Seattle, Wash.

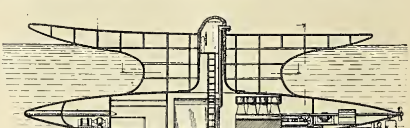
A standard rises from the deck of the vessel and a weighted pendulum is suspended from this standard and connected with an air-pump. The air-pump is se-



cured to the deck of the vessel and communicates with a storage tank. The motion of the vessel causes the pendulum to swing and thereby operate the air-pump. The air is forced into the storage tank, from which the compressed air may be utilized to drive machinery on the vessel or for other purposes.

631,417. Torpedo Boat. C. L. Burger, New York, N. Y.

Secures the advantages of both the surface and submarine torpedo-boat by employing a submarine hull carrying the guns, machinery, etc., and an upper cellular



hull filled with cork or similar substance so as to be unsinkable. The two hulls are connected by a small hollow web, and an armored air-shaft and conning-tower rises through the said web to form a means of communication between the two hulls.

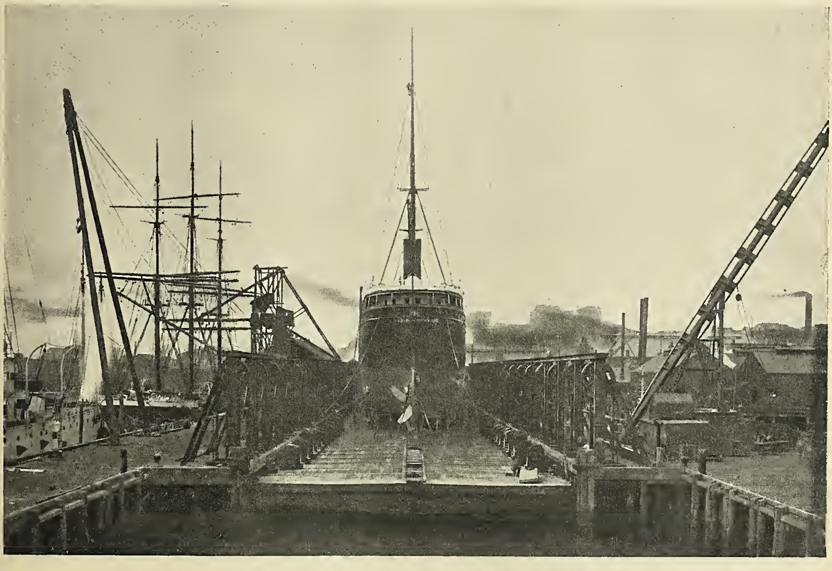
MARINE ENGINEERING.

Vol. 4. NEW YORK, NOVEMBER, 1899. No. 5

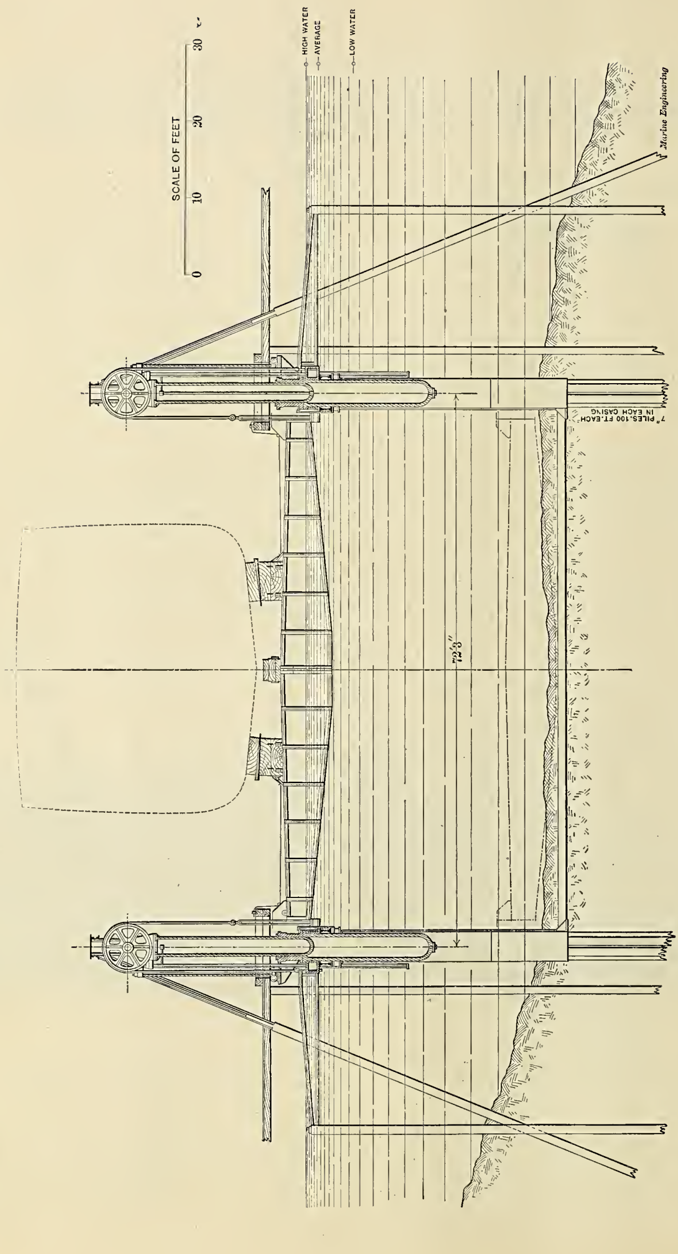
HYDRAULIC LIFTING DRY DOCK AT UNION IRON WORKS, SAN FRANCISCO.

One of the unique features of the equipment of the Union Iron Works, at San Francisco, is their hydraulic lift dock. When the works were moved to the present location, some years ago, one of the objects in view was to meet the demands of an increasing steamship trade, both for the repairing of old work and the building of new. Naturally one of the first requirements was a dry dock. A large portion of the dock work at San Francisco was at that time, and is at present, for the purpose of cleaning and painting, which, for most vessels, does not take more than one day. Speed in getting the dock and ship dry was therefore of prime importance. As the location of the dock was on a mud flat, with a depth of mud from 80 to 90 ft., it was seen at once that a graving dock would be a very difficult and disagreeable dock to clean, and very slow to dry. The mud, which is soft, would wash in every time the dock was opened, the tide at certain times being particularly favorable for that purpose. After a careful consideration of the requirements, and the many difficulties of construction, it was decided to build a lift dock. from the designs of G. W. Dickie, manager of the works.

This dock consists of a platform 62 ft. wide and 435 ft. long, made of steel girders, and raised and lowered by means of hydraulic rams, placed in a row along each side of the platform, as shown in the accompanying drawings. This platform carries the keel blocks, and is fitted with sliding bilge blocks, which can be operated from the surface. In operation the platform is lowered down, the vessel run in over the keel blocks, and the platform is then raised until the blocks touch the ship. The bilge blocks are now slid in until the ship is perfectly cradled, and the platform is moved up again,

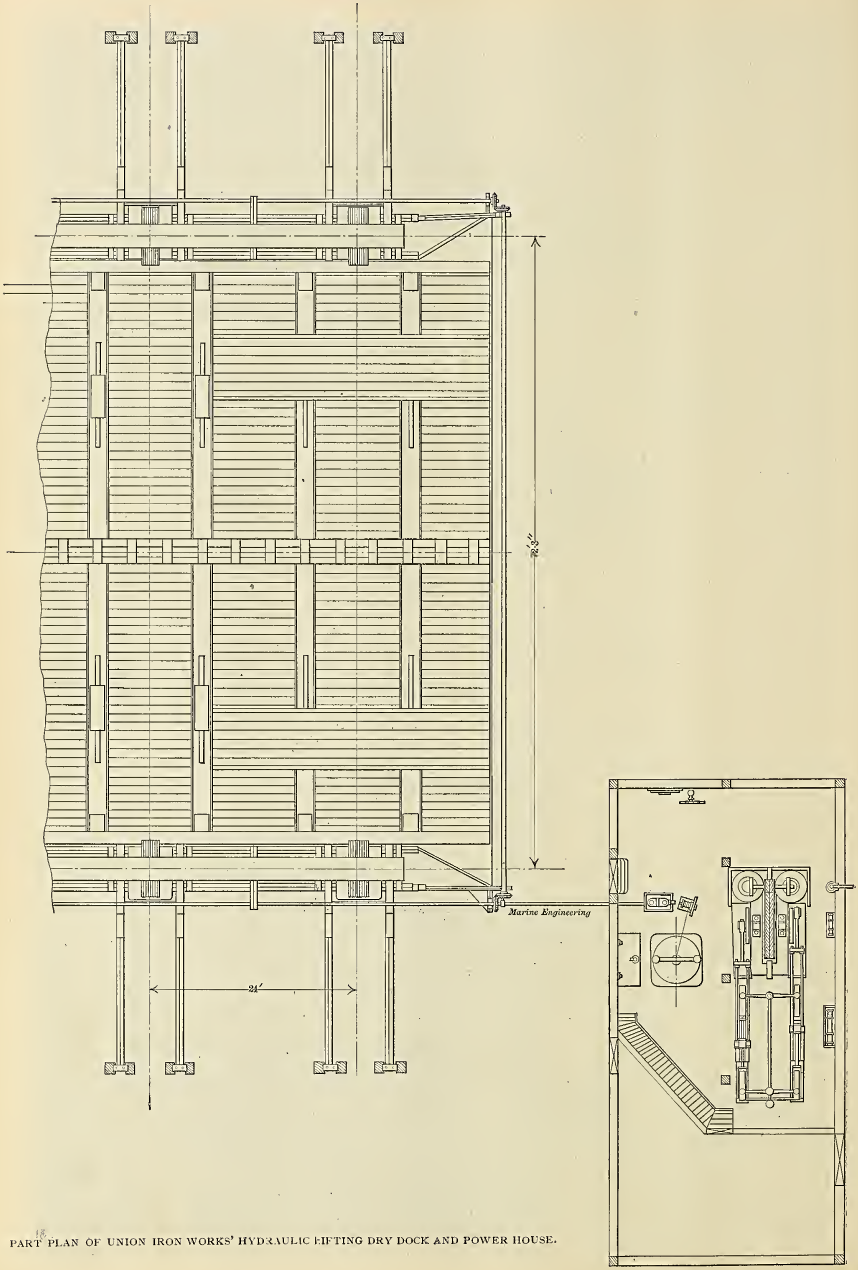


WATER FRONT VIEW OF HYDRAULIC LIFTING DOCK AT UNION IRON WORKS—S. S. COLON DOCKED.



CROSS SECTION OF HYDRAULIC LIFTING DRY DOCK IN THE SHIP YARD OF THE UNION IRON WORKS, SAN FRANCISCO, CAL.

PHOTOGRAPH OF HYDRAULIC LIFTING DRY DOCK AT THE SHIP YARD OF THE UNION IRON WORKS, SAN FRANCISCO, CAL.—U. S. GUNBOATS WHEELING AND MARIETTA ON DOCK.



PART PLAN OF UNION IRON WORKS' HYDRAULIC LIFTING DRY DOCK AND POWER HOUSE.

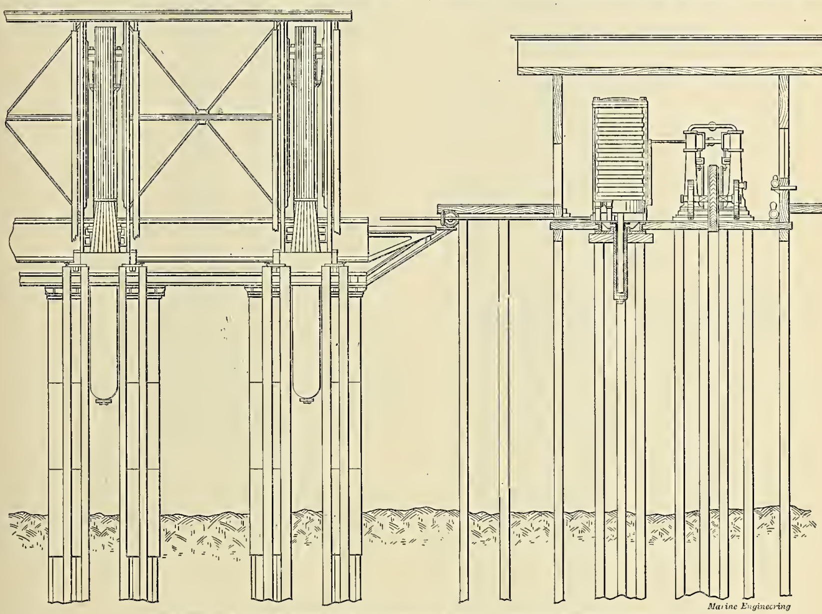
bringing its surface well above that of the water. This raises the ship clear above the water, where wind and sun rapidly dry the bottom. The platform itself is hosed off clean, and is as dry and comfortable to work on as could be desired. The rams, of which there are eighteen on a side, are 30.7 in. dia., and have a lift of 16 ft. At the upper end of each ram there is a rope sheave, 6 ft. dia., over which are passed eight steel cables, 2 in. dia. Each cable has been tested with a load of 80 tons. The outer ends of these cables are made fast to the foundation plates, and the inner ends to the longitudinal side girders of the platform. This arrangement gives the platform a lift of 32 ft. for 16 ft. lift of the rams. The depth of water over the keel blocks, at ordinary high water, is 22 ft. The upper ends of the rams work in vertical guides, held in place by, and forming part of, an iron superstructure, which runs the entire length of the dock. This superstructure is supported laterally by stays made fast to anchor piles, as shown in the drawings here published. The rams and cylinders are made of cast iron.

The foundations were not the least difficulty that had to be overcome. It was desired to rest the dock on piles; but the teredo is very destructive to piling on the Pacific coast. A group of piles, close together, was therefore driven at each foundation and covered with a cylindrical iron casing, extending down below the mud line. The piles fill the cylinder completely, and no pile is shorter than 90 ft. Two of these foundations were built for each hydraulic cylinder, which is supported from the top of the iron pile casings, by means of cross girders, and passes down between the foundations, as shown.

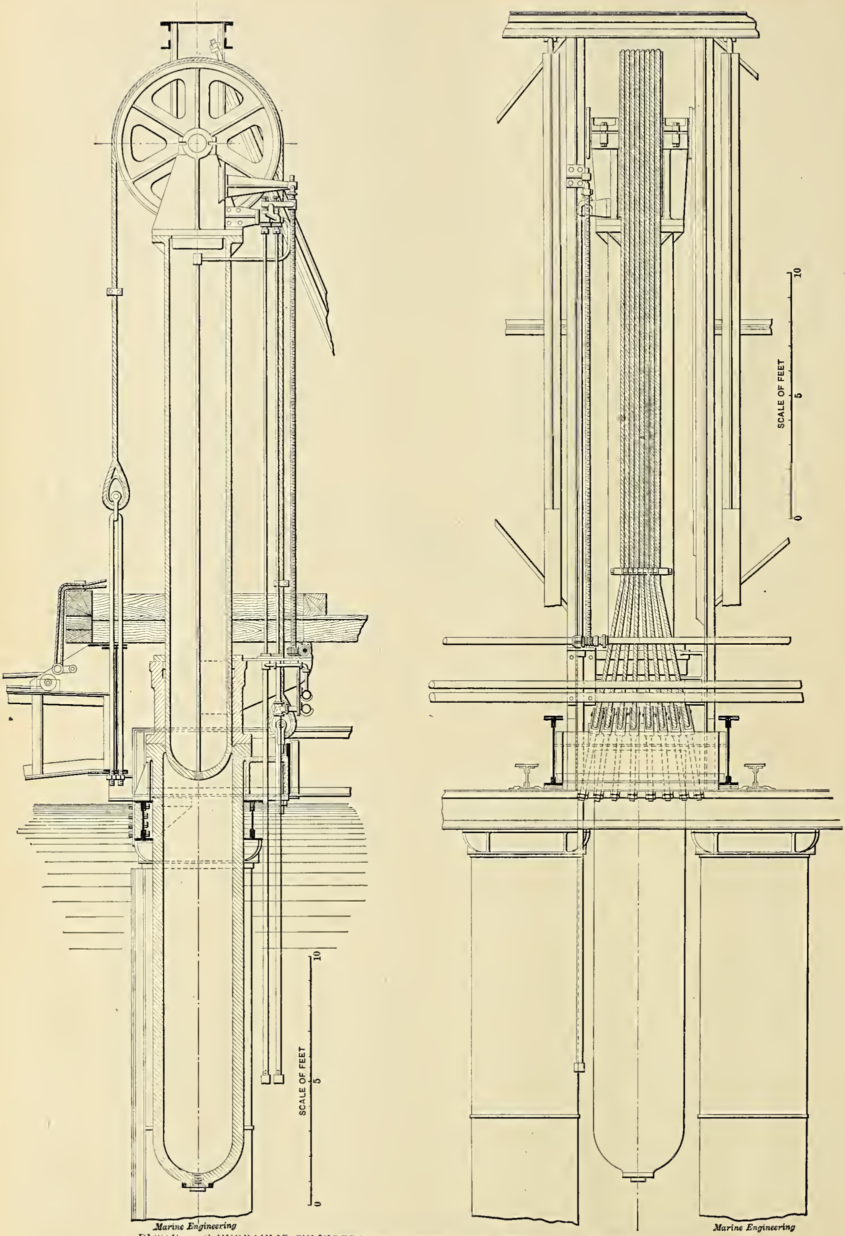
The lifting power is obtained from two double horizontal plunger pumps, having pistons 3 3-4 in. dia. and stroke of 36 in. They are driven, through gearing, by two vertical engines, with cylinders 12 in. dia., by 16 in. stroke of piston. The steam pressure is 90 lbs. per sq. in., and the maximum hydraulic pressure is 1,250 lbs. per sq. in. With this maximum pressure, the speed of the loaded platform is 3.2 in. per min. An accumulator is attached to the pump line, having its weights so arranged that the pressure on the dock rams is increased in proportion to the load on the platform.

When the platform is up, a line of locks, thirty-six on each side, is slipped under the edge by means of a hydraulic cylinder, the platform is then lowered until it rests upon them, and remains there while work on the ship is going on. When the vessel is ready for sea again the platform is raised a little, the locks are withdrawn and the platform lowered. While the platform rests on these locks, the accumulator is so attached to the pump engine as to maintain, automatically, pressure enough on the pipe line to supply waste and keep the cylinders full, but not enough pressure to raise the platform off the locks.

It is, evidently, impossible to distribute the weight of the platform and vessel evenly on all the rams, and even if that were possible the friction on the rams would not be the same, so that some of the rams would rise faster than others if means were not provided to prevent them doing so. For this purpose Mr. Dickie

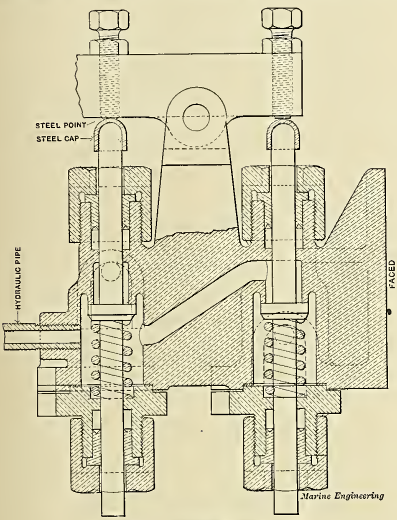


PART SIDE ELEVATION HYDRAULIC LIFTING DRY DOCK—SHOWING POWER HOUSE ALSO



DETAILS OF HYDRAULIC CYLINDERS AND LIFTING GEAR—HYDRAULIC LIFTING DRY DOCK.

designed the special distributing valve, shown in section on this page, and a special valve gear for operating the same. One of these valves is attached to the top of each ram, the feed and exhaust pipes sliding up and down through stuffing boxes in the foundation plates. Referring to the sectional drawing of this distributing valve, the small poppet valve on the right hand is the feed valve, while that on the left is the exhaust. These valves, as can be seen, are partially balanced and open against the pressure in both cases. They are thus self closing; although an auxiliary spring is also provided to assist in closing, thus securing more positive action. The delivery opening is shown at the left side of the valve. The 1-2 in. hydraulic pipe passes from this into the interior of the ram, near the top, goes down its center, and delivers into the cylinder through the bottom of the ram. The differential valve lever, also shown on the same drawing, is connected, at its outer end, by



HYDRAULIC DISTRIBUTING VALVE.

means of a nut to a vertical screw. This screw, in turn, is connected by worm gearing to a horizontal shaft, that runs down the side of the dock, the shafts on each side being rotated in unison by a small reversible engine in the power house. This construction is clearly shown in the accompanying drawings. When this rotating engine is started in the direction for raising the platform, the outer end of the differential lever is raised, the feed valve is opened a little, and the ram starts upward; and, as long as the ram continues to move upward as fast as the nut, the feed valve will remain slightly opened. Should it move faster than the nut, it will first allow the feed valve to close; and if it should still continue to move in advance, as might occur through excessive leakage of the feed valve, the exhaust valve will open, effectually checking the motion. Should the ram lag behind the nut, the feed valve will be opened wider and wider, until the supply is sufficient to force the ram up to its proper place. Means of adjustment are provided, and the distance which the ram can move ahead, or fall behind, is very small. Since every nut travels upward at the same speed, the rams all move in unison, and the floor of the platform remains in one plane, no matter how unevenly the load may be distributed. To lower the platform, the rotating engine is reversed, the action of the distributing valve being similar to that in going up, and the water in the cylinders is returned to a tank, from which it is used again in raising. The mechanism has worked exceedingly well, the dock having been in continuous service without mishap since its construction, twelve years ago.

The accompanying illustrations show the United States gunboats *Marietta* and *Wheeling* on the dock together, and also the Pacific Mail steamer *Colon*, as seen on the dock from the water front.

The main dimensions and principal data are as follows:

Total length of longitudinal girder	421 ft. 7 in.
Total length of platform on the keel	436 ft. 6 in.
Width of platform	65 ft. 7 in.
Maximum lift	32 ft.
Maximum lifting capacity	6,000 tons.
Maximum lifting capacity per ram	164 tons.
Number of rams	36
Number of foundation columns	72
Distance between centers of rams lengthways	24 ft. 0 in.
Distance between centers of rams crossway	72 ft. 3 in.
Diameter of plungers	30.7 in.
Eight 2 in. diameter steel ropes per ram.	
Two 12x16 vertical steam engines for pumps.	
Four pressure pumps, 36 in stroke; diameter of plungers of same	3 3-4 in.
One duplex 6x6 in. reversing engine for rotating valve shafts.	
One Worthington Duplex pump	4 1-2x1 3-8x4 in.
One accumulator 8 in. dia. of ram 48 in. stroke.	
Weight of ram head	12,000 lbs.
Weight of 11 pieces (adjustable weights)	47,500 lbs.
Weight of ram	2,500 lbs.
Total weight of ram and weights	62,000 lbs.

Average speed of pressure pumps 31 strokes per min.

Pressure for lifting { empty dock 275 lbs. per sq. in.; loaded dock 1,250 lbs per sq. in.

Speed of loaded platform with 1,250 lbs. pressure per sq. in. on rams, 3.2 in. per min.

Steam pressure, 90 lbs. per sq. in.

We are indebted to the Union Iron Works and George W. Dickie, manager, for the data and drawings, which were courteously placed at our disposal.

A pretty incident is related as having occurred at the launching of the S. S. *Augusta* from the yard of Neafie & Levy at Philadelphia, recently. Just as the new vessel commenced to move, the sponsor, Miss Jane H. Andrews, attempted unsuccessfully to break the customary bottle of champagne. In this emergency Miss Andrews plucked an American beauty rose from her corsage bouquet and, flinging it against the bow, christened the vessel.

For the convenience of vessels in Asiatic waters a new dry dock has been established at Shanghai, China, of the following dimensions: Length on blocks, 540 ft.; width at entrance, 80 ft.; depth of water over sill at ordinary spring tide, 24 ft. The shops adjoining the dock have been fitted with modern machinery for repair work. Among the vessels recently docked there was the North German Lloyd steamship *Konigsberg*, of about 7,000 tons load displacement.

A new floating dry dock for the port of Havana, to replace the one installed by the Spanish Government, and subsequently sold for removal to Vera Cruz, is among the probabilities of the future.

COMPARISON BETWEEN PERFORMANCES OF TWO SEA-GOING STEAMSHIPS.*—I.

BY J. D. M'ARTHUR, MEMBER.

While the author was relating his experiences in two steamers, belonging to different owners, it was suggested that the results, put in the form of a paper, might prove of interest to the Institute of Marine Engineers, contrasting as they do the economical working of a carefully designed ship and engines, with the performance of one built to sell and bought off the stocks.

The first steamer I will term A, the second B; and it may be mentioned that, between two sister ships, built to the specification of A, the difference of performance was very small, the second of the two possessing a fraction of a knot more speed, due to a slight alteration in the propeller, after experience acquired with the first.

The leading dimensions and particulars of machinery of the vessels undergoing comparison are as follows:

PARTICULARS.	A	B
Length between perpendiculars	392ft.	350ft.
Beam	46ft. 6in.	41ft. 6in.
Load draught	25ft. 4in.	24ft.
Nett registry tonnage	2.850	2.100
Dead weight capacity	6 800	5,200
Diameter of cylinders	27in., 42in., 69in.	24in., 39in., 64in.
Stroke of pistons	54in.	45in.
Revolutions at usual speed	57	61
Average I.H.P.	1,440	1,180
Diameter of propeller	18ft. 6in.	16ft. 6in.
Pitch do	18ft.	17ft. 6in.
No. of boilers and pressure	2—160lb.	2—170lb.
Mean diameter and length of do.	15ft. 3in. by 12ft.	14ft.9in. by 11ft.6in.
No. and diameter of furnaces	3 each, 3ft. 9in.	3 each, 3ft 6in.
Type of donkey boiler	Marine	Marine
Diameter and length of do.	9ft. 6in. by 11ft.	8ft. 6in. by 8ft
No. and diameter of furnaces	2—34in.	2—2ft. 7½in. at mouth, 2ft at back
Nature of draught	Howden's forced	Howden's forced
No. and size of winches	7—8in. cylinders	6—7in. cylinders
Dimensions of fan engine cylinder	8in. by 12in.	8in. by 12in.
Dimensions of electric cylinder	8in. by 12in.	——
Revolutions of electric engine	200	——
Do. dynamo	600	——
Average output of do	5,000 watts	——
Type of feed pumps	Weir's	Ordinary ram
Do. do. heater	Weir's	Morison's
Do. evaporator	Weir's	Morison's
Steering engine	Caldwell, 8in.	Caldwell, 7in.
Total No. of auxiliary engines, including pumps, ash hoists, winches	17	10
Average speed	9 knots	8.75 knots
Do. daily consumption of good Welsh coal	19 tons	21.5 tons
Do. consumption per I.H.P. per hour	1 23 b.	1.7lb.
Do. consumption per ton carried per mile	0316lb	.0488lb.
Date of launch	June, 1894	November, 1894

The figures in the last line but one are sufficient evidence that the saving effected by A, in comparison with B, would in a very short time write off, not only the interest on the extra cost, but the principal as well. In the case of A, it will be observed that, in addition to the main engines, steam had to be supplied to Weir's pump and evaporator, the fan engine, steering engine, electric engine (13 hours per day), ash-hoist (every watch), and in working out the lb. per I.H.P. no allowance is made for this, so that these (A) ships may fairly be classed amongst the most economical afloat.

The designs for these (A) ships emanated from one of the best-known marine engineer superintendents on the Clyde, and the arrangement throughout was as near perfection, in my opinion, as need be.

The usual H.P. piston-valve was done away with, and an ordinary double-ported slide-valve fitted, without relief-ring or any means of reducing the pressure between the faces, both of which were composed of special hard iron. At first oil was admitted with the steam by means of the sight-feed lubricator; but, there being no filter fitted, this soon caused trouble in the boilers, though, strangely enough, so far as could be seen, the surfaces of the condenser tubes did not appear to be much affected. It was then determined to try to run without any oil, except so much as got in with the piston-rods from swabbing; and, so far as valve-faces were concerned, this was done—with no bad results, while, of course, there was a saving of several days' work in the boilers every time they were opened, scraping grease off shell-plates, furnace-bottoms, combustion chambers, bottoms and tubes.

Buckley's springs were fitted to all the pistons, and the cylinders were in beautiful condition, the tool-marks being quite perceptible at the end of two years. The H.P. cylinder alone was fitted with a loose liner. The indicator cards, taken at ordinary sea speed—9 to 9 1-2 knots—from the H.P. engine, showed that this was not the most economical speed, for the expansion being run almost hard in, excessive compression and wire-drawing took place, consequent on the method adopted of diminishing work lost by friction by reduction of travel and size of valve, the former being only 4 1-2 in. and the maximum port opening to steam 15-16 in. each port.

The feed water was heated to a temperature of 220 deg. in Weir's heater, by steam taken from the L.P. casing, at a pressure of 10 or 11 lb. Either or both of the main engine feed-pumps were used to raise the water from the hot well to the heater, whence it was delivered to the boilers by Weir's pumps, each of which used to be worked alternately with the other. The evaporator possessed a capacity of 20 tons fresh water per day, steam being taken from the I.P. casing to the coils, and drained thence into the hot well, the vapor being generated at about 15 lb., and led to the L.P. casing in the usual manner. As a rule, the evaporator was in use only about nine hours per day, or in other words, supposing it to work at its maximum rate, the total amount of extra feed was about 7 1-2 tons per day, which, however, must be considered as over the actual quantity, glands, joints, etc., being in excellent condition; and, not only that, but before the scale which forms on the coils of Weir's evaporator cracks off it often attains a considerable thickness, even when due attention is paid to frequent blowing out and running up with cold water.

Compared with Morison's evaporator, in which live steam is used, there is a loss in this system; for, by passing the vapor into the heater in the former, fresh water is obtained at a cost, theoretically, of the heat lost through brining; while, in Weir's system, there is first the loss of the latent heat of the vapor generated, and second, the loss due to brining or blowing off.

The following figures may be of interest as comparing the cost of fresh water in the two cases:

* Read before the Institute of Marine Engineers, London, England.

Boiler Press Absolute	= 175 lb.	temperature	370.4 deg.
I.P. Casing " "	= 70 lb.	"	302.5 "
L.P. " " "	= 25 lb.	"	240 "
Evaporator Shell "	= 30 lb.	"	250 "
Hot well, without Evaporator		"	100 "
Discharge Water, for Evaporator Feed "			110 "

Density of evaporator 4-32, *i.e.*, quantity blown off = 1-3 evaporation.

The total heat of steam at 30 lb. absolute above temperature of water of 110 deg. is = 1,080 thermal units per lb., the heat lost by blowing down = 1-3 (250-100) thermal units per lb. evaporated; ∴ The total heat required to evaporate 1 lb. fresh water = 1,130 thermal units.

Suppose steam in the coils at 70 lb. all condensed to water of 292 deg., then the heat given up per lb. is = 912 thermal units, or, 1 lb. of steam taken from I.P. casing at 70 lbs., returns $\frac{912}{1130}$ = 8 lb. of steam to L.P. casing.

Let total I.H.P. of the engine $= P$

" " Extra feed $= x$ lbs. per hour.

" " Water per I.H.P. = 13.5 lb.

Then since the consumption is = 1.23 lb. per I.H.P. per hour, 1 lb. coal produces $\frac{13.5}{1.23} = 11$ lb. of steam at 370.4 deg. from water of 220 deg.

The quantity of steam required to make x lbs. water is $= \frac{x}{.8} = 1.25x$ lbs.

The quantity of steam returned to L.P. casing = x lbs.

Total steam passing H.P. Cylinder = 13.5 P lb. per hour, I.P. Cylinder = 13.5 P — $1.25x$, and L.P. Cylinder = 13.5 P — $.25x$.

Assuming power equally divided among the three engines, as it was in this case, I.H.P. of H.P. Engine $=\frac{1}{3}P$; I.P. $=\frac{1}{3}\left(P-\frac{1.25x}{13.5}\right)$; L.P. $=\frac{1}{3}\left(P-\frac{.25x}{13.5}\right)$

Total I.H.P. $= P - \frac{1\ 5x}{3\times 13.5} = P - .037x$;

∴ The loss of I.H.P. is $= .037x$, equivalent to $.037 \times 1.23$ lb. of coal (= .046) per lb. of water evaporated.

Now the heat returned to the hot well by drain water from the coils is = 302 — 100 = 202 thermal units per lb. condensed steam. Also 1 lb. of coal evaporates 11 lbs. of steam at 370.4 deg. from water of 220 deg., or thermal value of coal = 11 × (1,195—188) = 11.077 thermal units; ∴ Heat returned to hot well per lb. of steam condensed in the coils $= \frac{192}{11,077} = .0182$ lb. of coal; ∴ saving per lb. of fresh water evaporated = .0182 × 1.25 = .0227, and ∴ nett cost of 1 lb. of fresh water = .046 — .0227 = .0233 lb. of coal, or 1 lb. of coal will produce 41 lb. of water.

With Morison's evaporator, all the heat, except that lost by brining, being returned amongst the feed-water, the figures are much more simple.

Evaporator shell pressure 20 lb. absolute gives a temperature of 227 deg., and the evaporator feed 110 deg., while the density of the evaporator is $\frac{3}{32}$; the total heat required per lb. of fresh water evaporated

$$= \frac{227 - 110}{2} = 58.5 \text{ thermal units.}$$

Taking the value of a lb. of coal as 9 lb. of water, in this case evaporated at 370.4 deg. (the usual working pressure being 160 lb.), from feed-water of 180 deg.:— 1 lb. of coal = 9 × (1,195—[180—32]) = 9,423 units; ∴ lbs. of water per lb. of coal $= \frac{9,423}{58.5} = 161$, or nearly four times the production of A's. The coal required to generate the supply of fresh water in A at the above figures works out at very approximately 1 per cent of the consumption, and in B at .03 per cent.

But if Weir's heater be taken into account, as is only fair, the advantage undoubtedly lies with it, as the following will show:

Steam is taken from the L.P. casing at a temperature of 240 deg., and mixing with the water in the heater at a temperature of 110 deg., raises it to 220 deg.

Let x lb. steam be taken per lb. of water heated, then $1,155x + (110—32) = (x + 1)\ (220—32)\ 967x = 110$ lb., and $x = .114$ lb.

Let y denote the fraction of 1 lb. of steam left in casing per original lb., then .114 y denotes the fraction required in the heater $1.114\ y = 1$ lb., $y = .89$ lb.

Supposing, as before, power is equally distributed, then of one H.P. throughout the whole engine, only $.89 \times \frac{1}{3} = .3$ is developed in the L.P. engine; ∴ only $.66 + .3 = .966$ I.H.P. remains, or with heater in use I.H.P. is only 96.6 per cent of what it is without the heater.

The fuel required is $= 100 \times \frac{1,017}{1,117} = 91$ per cent;

∴ " " to get original H.P. $= 91 \times \frac{100}{96.6}$ = 94.2 per cent, and ∴ the saving of fuel = 5.8 per cent, and cost of fresh water = 1 per cent, thus giving a nett saving of fuel = 4.8 per cent, when using evaporator and heater, as against a nett cost of .03 per cent of the fuel when evaporating 10 tons per day in Morison's evaporator and heater as in B.

The above figures are only given as relating to the different cases under present consideration, and the greater part of the data is taken from actual working.

Another point that might be noticed is that Weir's pumps, though as near perfection as can be had, are by no means remarkably economical with regard to steam, although they may in a manner be compounded by turning the exhaust into the L.P. casing, as is usually done; still taking into account the diminished friction at the main feed pump glands, and the high temperature at which it is possible to deliver the feed, the balance may be pretty even; it is unquestionable that with Weir's pumps there is an immense saving in the tear and wear of valves and pipes.

In both steamships A and B, Auld's reducing valves were used, but while in the former all the auxiliaries with the exception of Weir's pumps were arranged to work either with reduced or high pressure steam, the first-mentioned was invariably used (80 lb.); in the latter both fan and steering engines worked at full boiler pressure, a great source of waste, for besides the difficulty of keeping glands, valves and pistons tight, there is bound to be excessive condensation in the pipes. On the other hand, by reducing the pressure of the steam, it is practically superheated, and not only so, but a greater volume being required to perform the same amount of work, the flow through the pipes is

much more rapid, so that the temperature of the pipe is thereby maintained more uniform.

In A.—The fan and electric engines were duplicate, and the arrangement was such as to permit of the belts being changed, and thus each engine could be used to drive either the fan or dynamo. The belts used were Tullis' patent hinged chain belts, which lasted well, and drove without much slip, considering that the slack side was below. Sheet iron troughs were fitted in the eccentric pits and filled with fresh water; this soon worked up into a fine lather with the oil, and besides the drip from the valve spindle glands, little water was used in keeping them full. The eccentric sheaves had a working face 4 in. wide, both straps and sheaves being of cast iron, and the upper halves of the go-ahead straps filled with white metal. The result obtained was very satisfactory, wear being slight and faces like silver. That these engines were otherwise good-running jobs will be appreciated when I say that after running 15,000 miles all the slack in the crank-pins was taken up by removing a brown paper liner, or = 1-4 in. on the nuts. Salt water as a lubricant was carefully avoided throughout the engine-room and tunnel, although the tunnel bearings ran so warm that they could hardly be touched, and the thrust temperature was somewhere in the vicinity of 200 deg. Fahr.

The shafting was turned bright throughout, and the absence of water permitted of its being kept so, and also saved a lot of labor and material in keeping the tunnel plates and floor free from rust.

The cylinder and casing drains were each led into the condenser by a separate pipe and valve, and Weir's pumps being arranged to draw from the condenser, all the steam used in the process of warming up was returned to the boilers, so that instead of the level falling, it really rose at the expense of the donkey boiler, as all exhausts were turned into the condenser.

Pipe-flanges were of extra strength, so that such a thing as a blowing joint was of rare occurrence, thus obviating a frequent cause of waste. Clearance spaces in the cylinders were small, and before leaving the shop the slide-valves were carefully set and expansion blocks graduated in inches of the stroke corresponding to the different cut-offs, the ranges being in the H.P. from 23 3-4 ins. to 33 1-2 in., I.P. 22 1-4 in. to 32 in., and L. P. 21 in. to 29 1-2 in. That the high pressure slide-valve was perfectly tight after several months running, was evident from the fact that the author, while working in or out of port, was never in the habit of shutting the stop-valve, even when stopped for 15 or 20 minutes, but used the throttle alone—which was one of the type whose position when closed is at right angles to the center line of the pipe—without any perceptible increase in the pressure of the I.P. casing, all drains being shut.

Reconstruction of the U. S. S. Hartford.

Admiral Farragut's old flagship, the *Hartford*, has been placed in commission at the Mare Island Navy Yard, California. Lightly sparred, but heavy of hull and armament, the proud victor of many hard fought naval battles swings at the buoy in the stream off the Ordnance Building ready for her trip around the Horn, which is to take place at a date soon to be fixed by the Navy Department. Ten years ago the *Hartford* steamed into San Francisco bay after a voyage from the Asiatic Station, her flag was hauled down and a Board of Survey reported that the cost of repairs would exceed the 20 per cent of original cost permitted by law. The ship was therefore condemned and ordered sold.

To-day the famous fighter is one of the most unique and comfortable ships in the new Navy. She is indeed a wooden craft, but in all other respects she is strictly up-to-date, with new machinery, a fine battery of 5-in. rapid fire guns, electric plant, ice plant; in short, she possesses an equipment such as would be carried on a more formidable vessel, and at the same time she is a floating home for officers and crew. The masts are short and carry but a few yards. Her crew is made up of landsmen who have yet to be trained in the art of sailing, and there is just enough left of the original spars to give the men a chance to spread a little canvas.

In working the ship over the original timbers were preserved as far as was practicable, great care being exercised in keeping anything but the hardest wood out of the hull. Most of the original wood is to be found in the keel and about the magazines. A large portion of the tough old deck-planks was taken out of the ship altogether and made into souvenir canes, which were eagerly sought by navy people.

To the people of Vallejo, just across the Straits from the Navy Yard, is due the credit of securing favorable action in the matter of an appropriation for the reconstruction of the *Hartford*. The Board of Trade of that city four years ago took up the fight and succeeded in securing the money needed with the understanding that the funds be used as follows: $276,000 for restoring the hull, $150,000 for boilers and engines, $150,000 for armament.

The Navy Department ordered the engines made at the New York Navy Yard, but this order was afterward rescinded, and the Mare Island Yard did the work. Construction was commenced as soon as authority was wired, under the supervision of Chief Engineer George F. Kutz, who was retired before the work was completed. Captain Joseph Trilley, lately retired, took up the work where Engineer Kutz had left off and carried it through to the finish.

Regarding the *Hartford* engines, they are of the horizontal compound back-acting type; high pressure cylinder 35 in. dia. and low pressure 68 in. dia. and 48 in. stroke. Two thousand indicated horse-power is expected when running 75 revolutions per minute. The boilers are four single Scotch type, 11 ft. 1 1-2 in. outside dia. and 10 ft. long. They are constructed for a working pressure of 110 lbs. to the sq. in. The firerooms are fore and aft, with two boilers in each. The total heating surface is 6,340 sq. ft. There are two forced draft blowers, one main and one auxiliary feed pump and one fire and bilge pump. There is also a steam steering gear.

The ship is still on her original lines. She was built at Boston in 1858 and in dimensions is 225 ft. long over all, 44 ft. beam, 18 ft. 6 in. draft, and 2,790 tons displacement. In the place of the old-time 9-in. guns the ship now has fifteen 5-in. rapid fire guns, four 6-pounders, one 3-pounder rapid fire gun, and two Colt rifles. She will have 450 recruits on board.

U. S. S. HARTFORD AS SHE APPEARED IN HER ORIGINAL RIG BEFORE RECONSTRUCTION.

U. S. TRAINING SHIP HARTFORD, RECONSTRUCTED AND RE-ENGINED AT MARE ISLAND NAVY YARD, CALIFORNIA.

REVIEW OF PAST PROGRESS IN STEAM NAVIGATION AND FORECAST OF FUTURE DEVELOPMENT.*—I.

BY SIR WILLIAM WHITE, CONSTRUCTOR-IN-CHIEF, R. N.

In this address it is proposed to review briefly the characteristic features of the progress made in steam navigation; to glance at the principal causes of advance in the speeds of steamships and in the lengths of the voyages on which such vessels can be successfully employed; and to indicate how the experience and achievement of the last sixty years bear upon the prospects of further advance.

On this occasion no attempt will be made either to summarize or appraise the work that has been done. It must suffice to mention the names of three men to whom naval architects are deeply indebted, and whose labors are ended—Scott Russell, Rankine, and William Froude. Each of them did good work, but to Froude we owe the device and application of the method of model experiment with ships and propellers by means of which the design of vessels of novel types and unprecedented speeds can now be undertaken with greater confidence than heretofore.

As speeds increase, each succeeding step in the ascending scale becomes more difficult, and the rate of increase in the power to be developed rapidly augments. Looking back on what has been achieved, it is impossible to overrate the courage and skill displayed by the pioneers of steam navigation, who had at first to face the unknown, and always to depend almost entirely on experience gained with actual ships, when they undertook the production of swifter vessels. Their successors of the present day have equal need to make a thorough study of the performances of steamships, both in smooth water and at sea. In many ways they have to face greater difficulties than their predecessors, as ships increase in size and speed. On the other hand, they have the accumulated experience of sixty years to draw upon, the benefit of improved methods of trials of steamships. the advantage of scientific procedure in the record and analysis of such trials, and the assistance of model experiments.

Steamship design to be successful must always be based on experiment and experience as well as on scientific principles and processes. It involves problems of endless variety and great complexity. The services to be performed by steamships differ in character, and demand the production of many distinct types of ships and propelling apparatus. In all these types, however, there is one common requirement—the attainment of a specified speed. And in all types there has been a continuous demand for higher speed.

Stated broadly, the task set before the naval architect in the design of any steamship is to fulfil certain conditions of speed in a ship which shall not merely carry fuel sufficient to traverse a specified distance at that speed, but which shall carry a specified load on a limited draught of water. Speed, load, power, and fuel supply, are all related, and the two last have to be determined in each case. In some instances, other limiting conditions are imposed, affecting length, breadth or depth. In all cases there are three separate efficiencies to be considered: those of the ship, as influenced by her form; of the propelling apparatus, including the generation of steam in the boilers and its utilization in the engines, and of the propellers. Besides these considerations the designer has to take account of the materials and structural arrangements which will best secure the association of lightness with strength in the hull of the vessel. He must select those types of engines and boilers best adapted for the service proposed. Here the choice must be influenced by the length of the voyage, as well as the exposure it may involve to storm and stress. Obviously the conditions to be fulfilled in an ocean-going passenger steamer of the highest speed, and in a cross-channel steamer designed to make short runs at high speed in comparatively sheltered waters, must be radically different. And so must be the conditions in a swift sea-going cruiser of large size and great coal endurance, from those best adapted for a torpedo boat or destroyer. There is, in fact, no general rule applicable to all classes of steamships; each must be considered and dealt with independently, in the light of the latest experience and improvements. For merchant ships there is always the commercial consideration: Will it pay? For warships there is the corresponding inquiry: Will the cost be justified by the power and efficiency of the proposed ship?

CHARACTERISTICS OF PROGRESS IN STEAM NAVIGATION.

Looking at the results so far attained, it may be said that progress in steam navigation has been marked by the following characteristics:

(1) Growth in dimensions and weights of ships, and large increase in engine power as speeds have been raised. (2) Improvements in marine engineering, accompanying increase of steam pressure. Economy of fuel and reduction in the weight of propelling apparatus in proportion to the power developed. (3) Improvements in the materials used in shipbuilding; better structural arrangements; relatively lighter hulls and larger carrying power. (4) Improvements in form, leading to diminished resistance and economy of power expended in propulsion. These general statements represent well-known facts—so familiar indeed that their full significance is often overlooked. It would be easy to multiply illustrations, but only a few representative cases will be taken.

TRANSATLANTIC PASSENGER STEAMERS.

The transatlantic service naturally comes first. It is a simple case, in that the distance to be covered has remained practically the same, and that for most of the swift passenger steamers cargo-carrying capacity is not a very important factor in the design. In 1840 the Cunard steamer *Britannia*, built of wood, propelled by paddle-wheels, maintained a sea speed of about 8 1-2 knots. Her steam pressure was 12 lb. per sq. in. She was 207 ft. long, about 2,000 tons in displacement, her engines developed about 750 horse power, and her coal consumption was about 40 tons per day, nearly 5 lb. of coal per indicated horse power per hour. She had a full spread of sail. In 1871 the White Star steamship *Oceanic*—first of that name—occupied a leading position. She was iron-built, propelled by a screw, and maintained a sea-speed of about 14 1-2 knots. The steam pressure was 65 lb. per sq. in., and the engines

*From a paper read before the British Association, Mechanical Science Section.

were on the compound principle. She was 420 ft. long, about 7,200 tons in displacement, her engines developed 3,000 horse power, and she burnt about 65 tons of coal per day, or about 2 lb. per indicated horse power per hour. She carried a considerable spread of sail. In 1889 the White Star steamer *Teutonic* appeared, propelled by twin screws, and practically with no sail power. She is steel-built, and maintains a sea speed of about 20 knots. The steam pressure is 180 lb. per sq. in., and the engines are on the triple expansion principle. She is about 565 ft. long, 16,000 tons in displacement, 17,000 horse power indicated, with a coal consumption of about 300 tons a day, or from 1.6 to 1.7 lb. per indicated horse power per hour. In 1894 the Cunard steamship *Campania* began her service with triple-expansion engines, twin screws, and no sail power. She is about 600 ft. long, 20,000 tons displacement, develops about 28,000 horse power at full speed of 22 knots, and burns about 500 tons of coal per day. The new *Oceanic* of the White Star Line is just beginning her work. She is of still larger dimensions, being 685 ft. in length, and over 25,000 tons displacement. From the authoritative statements made it appears that she is not intended to exceed 22 knots in speed, and that the increase in size is to be largely utilized in additional carrying power. The latest German steamers for the transatlantic service are also notable. A speed of 22 1-2 knots has been maintained by the *Kaiser Wilhelm der Grosse*, which is 25 ft. longer than the *Campania*. Two still larger steamers are now building. The *Deutschland* is 660 ft. long, and 23,000 tons displacement; her engines are to be of 33,000 horse power, and it is estimated that she will average 23 knots. The other vessel is said to be 700 ft. long, and her engines are to develop 36,000 horse power, giving an estimated speed of 23 1-2 knots. All these vessels have steel hulls and twin screws. It will be noted that to gain about 3 knots an hour nearly 50 per cent will have been added to the displacement of the *Teutonic*, the engine power and coal consumption will be doubled, and the cost increased proportionately.

Sixty years of continuous effort and strenuous competition on this great "ocean ferry" may be summarized in the following statement: Speed has been increased from 8 1-2 to 22 1-2 knots; the time on the voyage has been reduced to about 38 per cent of what it was in 1840. Ships have been more than trebled in length, about doubled in breadth, and increased tenfold in displacement. The engine power has been made forty times as great. The ratio of horse power to the weight driven has been increased fourfold. The rate of coal consumption—measured per horse power per hour—is now only about one-third what it was in 1840. To drive 2,000 tons weight across the Atlantic at a speed of 8 1-2 knots per hour, about 550 tons of coal were then burnt; now, to drive 20,000 tons across at 22 knots, about 3,000 tons of coal are burnt. With the low pressure of steam and heavy slow-moving paddle-engines of 1840, each ton weight of machinery, boilers, etc., produced only about 2 horse power. With modern twin-screw engines and high steam pressure, each ton weight of propelling apparatus produces from 6 horse power to 7 horse power. Had the old rate of coal consumption continued, instead of 3,000 tons of coal, 9,000 tons would have been required for a voyage at 22 knots. Had the engines been proportionately as heavy as those in use sixty years ago they would have weighed about 14,000 tons. In other words, machinery, boilers, and coals would have exceeded in weight the total weight of the *Campania* as she floats to-day. There could not be a more striking illustration than this of the close relation between improvements in marine engineering and the development of steam navigation at high speeds.

Equally true is it that this development could not have been accomplished but for the use of improved materials and structural arrangements. Wood, as the principal material for the hulls of high-powered swift steamers, imposed limits upon dimensions, proportions and powers, which would have been a bar to progress. The use of iron first and since of steel removed those limits. The percentage of the total displacement devoted to hull in a modern Atlantic liner of the largest size is not much, if at all, greater than was the corresponding percentage in the wood-built *Britannia* of 1840, of one-third the length and one-tenth the total weight. Nor must it be overlooked that with increase in dimensions have come considerable improvements in form favoring economy in propulsion. This is distinct from the economy resulting from increase in size, which Brunel appreciated thoroughly half a century ago when he designed the *Great Britain* and the *Great Eastern*. The importance of a due relation between the lengths of the "entrance and run" of steamships and their intended maximum speeds, and the advantages of greater length and fineness of form as speeds are increased, were strongly insisted upon by Scott Russell and Froude. Naval architects, as a matter of course, now act upon the principle, so far as other conditions permit. For it must never be forgotten that economy of propulsion is only one of many desiderata which must be kept in view in steamship design. Structural weight and strength, seaworthiness, and stability, all claim attention, and may necessitate modifications in dimensions and form which do not favor the maximum economy of propulsion. Increase in length and weight have largely assisted the marvelous regularity of service now attained on the longest passages by swift steamships. Even the largest vessels at times have to yield to the forces of nature displayed in wind and sea. But these conditions are more rarely reached in the longer and heavier ships.

SWIFT PASSENGER STEAMERS FOR LONG VOYAGES.

Changes similar to those described for the transatlantic service have been in progress on all the great lines of ocean traffic. In many instances increase in size has been due not only to increase in speed, but to enlarged carrying power, and the extension of the lengths of voyages. No distance is now found too great for the successful working of steamships, and the sailing fleet is rapidly dimininshing in importance. So far as long-distance steaming is concerned, the most potent factor has undoubtedly been the marvellous economy of fuel that has resulted from higher steam pressures and greater expansion. In all cases, however, advances have been made possible not merely by economy of fuel, but by improvements in form, struc-

ture and propelling apparatus, and by increased dimensions. Did time permit, this might be illustrated by many interesting facts drawn from the records of the great steamship companies which perform the services to the Far East, Australia, South America, and the Pacific. As this is not possible, I must be content with the statement of a few facts regarding the development of the fleet of the Peninsular and Oriental Company:

The paddle steamer *William Fawcett*, of 1829, was about 75 ft. long, 200 tons displacement, of 60 nominal horse power—probably about 120 indicated horse power—and in favorable weather steamed at a speed of 8 knots. Her hull was of wood, and, like all the steamers of that date, she had considerable sail power. In 1853 the *Himalaya*, iron-built screw steamer of this line, was described as "of larger dimensions than any then afloat, and of extraordinary speed." She was about 340 ft. long, over 4,000 tons load displacement, 2,000 indicated horse power on trial, with an average sea speed of about 12 knots. The steam pressure was 14 lb. per sq. in., and the daily coal consumption about 70 tons. This vessel was transferred to the Royal Navy, and did good service as a troopship for forty years. In 1893 another *Himalaya* was added to the company's fleet. She was steel-built, nearly 470 ft. long and 12,000 tons load displacement, with over 8,000 indicated horse power and a capability to sustain 17 to 18 knots at sea, on a daily consumption of about 140 tons of coal. The steam pressure is 160 lb. per sq. in., and the engines are of the triple-expansion type. Comparing the two *Himalayas*, it will be seen that in forty years the length has been increased about 40 per cent, displacement trebled, horse power quadrupled, and speed increased 50 per cent. The proportion of horse power to displacement has only been increased as three to four, enlarged dimensions having secured relative economy in propulsion. The rate of coal consumption has been probably reduced to about one-third of that in the earlier ship. The latest steamers of the line are of still larger dimensions, being 500 ft. long and of proportionately greater displacement. It is stated that the *Himalaya* of 1853 cost $660,000 complete for sea; the corresponding outlay on her successors is not published, but it is probably twice as great.

On the service to the Cape of Good Hope similar developments have taken place. Forty years ago vessels less than 200 ft. long and about 7 knots performed the service, whereas the latest additions to the fleets exceed 500 ft. in length, and can, if required, be driven at 17 to 18 knots, ranking in size and power next to the great transatlantic liners. Commercial considerations necessarily regulate what is undertaken in the construction of merchant steamers, including the swift vessels employed in the conveyance of passengers and mails. The investment of $3,000,000 to $3,500,000 in a single vessel like a great transatlantic liner is obviously a serious matter for private owners; and even the investment of half that amount in a steamer of less dimensions and speed is not to be lightly undertaken.

It is a significant fact that, whereas fifteen years ago nearly all the largest and swiftest ocean steamers were British built and owned, at the present time there is serious competition in this class by German, American and French companies. It is alleged that this change has resulted from the relatively large subsidies paid by foreign governments to the owners of swift steamers; and that British owners, being handicapped in this way, cannot continue the competition in size and speed on equal terms unless similarly assisted. This is not the place to enter into any discussion of such matters. But they obviously involve greater considerations than the profit of ship-owners, and have a bearing on the naval defence of the Empire. In 1887 the Government recognized this fact, and made arrangements for the subvention and armament of a number of the best mercantile steamships for use as auxiliary cruisers. Since then other nations have adopted the policy, and given such encouragement to their shipowners that the numbers of swift steamers suitable for employment as cruisers have been largely increased. Not long since the First Lord of the Admiralty announced to Parliament that the whole subject was again under consideration.

Cargo steamers, no less than passenger steamers, have been affected by the improvements mentioned. Remarkable developments have occurred recently, not merely in the purely cargo carrier, but in the construction of vessels of large size and good speed, carrying very great weights of cargo and considerable numbers of passengers. The much-decried "ocean tramp" of the present day exceeds in speed the passenger and mail steamer of fifty years ago. Within ten years vessels in which cargo-carrying is the chief element of commercial success have been increased in length from 300 ft. or 400 ft. to 500 ft. or 600 ft.; in gross register tonnage from 5,000 to over 13,000 tons, and in speed from 10 or 12 knots to 15 or 16 knots. Vessels are now building for the Atlantic service which can carry 12,000 to 13,000 tons deadweight, in addition to passengers, while possessing a sea-speed as high as that of the swiftest mail steamers afloat in 1880. Other vessels of large carrying power and good speed are running on much longer voyages, such as to the Cape and Australia. In order to work these ships successfully very complete organization is necessary for the collection, embarkation, and discharge of cargo. The enterprise and skill of shipowners have proved equal to this new departure, as they have in all other developments of steamships.

How much further progress will be made in the sizes and speeds of these mixed cargo and passenger steamers cannot be foreseen. The limits will be fixed by commercial considerations, and not by the capability of the shipbuilder. In passing it may be noted that while the lengths and breadths of steamships have been greatly increased, there has been but a moderate increase in draft. Draft of water is, of course, practically determined by the depths available in the ports and docks frequented, or in the Suez Canal for vessels trading to the East. From the naval architect's point of view increase in draught is most desirable as favoring increase of carrying power and economy of propulsion. This fact has been strongly represented by shipowners and ship designers, and not without result. The responsible authorities of many of the principal ports and of the Suez Canal have taken action towards giving greater depth. Other changes have become necessary on the part of dock and port authorities in consequence of the progress made in shipbuilding.

Docks and dock entrances have had to be increased in size, more powerful lifting appliances provided, and large expenditure incurred. There is no escape from these changes if the trade of a port is to be maintained. The chief lesson to be learned from past experience is that when works of this character are planned it is wise to provide a large margin beyond the requirements of existing ships.

CROSS-CHANNEL STEAMERS.

The conditions to be fulfilled in vessels designed to steam at high speed for limited periods obviously differ essentially from those holding good in ocean-going steamers. None the less interest attaches, however, to cross-channel steamers, and in no class has more notable progress been made. It is much to be desired that, at this meeting, some competent authority should have presented to the association an epitome of the history of the steam-packet service between Dover and the Continent. I cannot attempt it. So far as I am informed, the first steamer was placed on this route in 1821, was of 90 tons burden, 30 horse power nominal, and maintained a speed of 7 to 8 knots. She was built by Denny, of Dumbarton, engined by Robert Napier, and named the *Rob Roy*. It is interesting to note that the lineal successors of the builder of this pioneer vessel have produced some of the most recent and swiftest additions to the cross-channel service. In 1861-2 a notable advance was made by the building of vessels which were then remarkable for structure and speed, although small and slow when compared with vessels now running. Their designers realized that lightness of hull was of supreme importance, and with great trouble and expense obtained steel of suitable quality. The machinery was of special design, and relatively light for the power developed. A small weight of coal and cargo had to be carried, and the draft of water was kept to about 7 ft. Under then existing conditions it was a veritable triumph to attain speeds of 15 to 16 knots in vessels only 190 ft. long, less than 25 ft. broad, and under 350 tons in displacement. To raise the trial speed to 21 or 22 knots in later vessels, whose design includes the improvements of a quarter of a century, it has been found necessary to adopt lengths exceeding 320 ft., and breadths of about 35 ft., with engines developing 4,500 to 6,000 indicated horse power, and with very great increase in coal consumption and cost.

Another interesting contrast is to be found in the comparison of the mail steamers running between Holyhead and Kingstown in 1860, and at the present time. The *Leinster* of 1860 was 328 ft. long, 35 ft. broad, and rather less than 13 ft. draft. Her trial displacement was under 2,000 tons, and with 4,750 horse power she made 17 3-4 knots. She had a steam pressure of 25 lb. per sq. in., and was propelled by paddle-wheels driven by slow-moving engines of long stroke. Her successor of 1896 is about 30 ft. greater length, 6 1-2 ft. greater breadth, and about 10 per cent greater displacement. The steam pressure is 160 lb. per sq. in. Forced draft is used in the stokehold. Twin screws are adopted, driven by quick-running vertical engines of the triple-expansion type. Very great economy of coal consumption is thus secured, as compared with the earlier vessel, and much lighter propelling apparatus in proportion to the power, which is from 8,000 horse power to 9,000 horse power at the full speed of 23 knots. The hull is built of steel, and is proportionately lighter. This is a typical case, and illustrates the effect of improvements in shipbuilding and engineering in thirty-five years. The later ship probably requires to carry no greater load of coal than, if so great as, her predecessor, although her engine power is nearly double. The weight devoted to propelling machinery and boilers is probably not so great. Thanks to the use of steel instead of iron, and to improved structural arrangements, the weight of hull is reduced in comparison with dimension, and a longer ship is produced better adapted to the higher speed. Messrs. Laird, of Birkenhead, who built three of the *Leinster* class forty years ago, and have built all the new vessels, are to be congratulated on their complete success. Between such vessels designed for short runs at high speed, and requiring therefore to carry little coal, while the load carried exclusive of coal is trifling, and an ocean-going steamer of the same average speed designed to make passages of 3,000 miles, there can obviously be little in common. But equal technical skill is required to secure the efficient performance of both services. In the cross-channel vessel, running from port to port and under constant observation, conditions of working in engine and boiler-rooms, as well as relative lightness in scantlings of hull, can be accepted which would be impossible of application in the sea-going ship. These circumstances, in association with the small load carried, explain the apparent gain in speed of the smaller vessel in relation to her dimensions.

INCREASE IN SIZE AND SPEED OF WARSHIPS.

Turning from sea-going ships of the mercantile marine to warships, one finds equally notable facts in regard to increase in speed, associated with enlargement in dimensions and advance in propelling apparatus, materials of construction, structural arrangements and form. Up to 1860 a measured-mile speed of 12 to 13 knots was considered sufficient for battleships and the largest classes of cruisers. All these vessels possessed good sail power, and used it freely as an auxiliary to steam or as an alternative when cruising or making passages. When armored battleships were built (1859) the speeds on measured-mile trials were raised to 14 or 14 1-2 knots, and so remained for about twenty years. Since 1880 the speeds of battleships have been gradually increased, and in the latest types the measured-mile speed required is 19 knots. Up to 1870 the corresponding speeds in cruisers ranged from 15 to 16 knots. Ten years later the maximum speeds were 18 to 18 1-2 knots in a few vessels. Since then trial speeds of 20 to 23 knots have been attained, or are contemplated.

There is, of course, a radical distinction between these measured-mile performances of warships and the average sea speeds of merchant steamers above described. But for purposes of comparison between warships of different dates measured-mile trials may fairly be taken as the standard. For long-distance steaming the power developed would necessarily be much below that obtained for short periods, and with everything at its best. This is frankly recognized by all who are conversant with warship design, and fully allowed for in estimates of sea speeds. On the other hand it is possible to

point to sea trials made with recent types where relatively high speeds have been maintained for long periods. For example, the battleship *Royal Sovereign* has maintained an average speed of 15 knots from Plymouth to Gibraltar, and the *Renown* has maintained an equal speed from Bermuda to Spithead. As instances of good steaming by cruisers, reference may be made to 60-hour trials with the *Terrible*, when she averaged over 20 knots, and to the run home from Gibraltar to the Nore by the *Diadem*, when she exceeded 19 knots. Vessels of the *Pelorus* class of only 2,100 tons displacement have made long runs at sea averaging over 17 knots. Results such as these represent a substantial advance in speed of Her Majesty's ships in recent years. Similar progress has been made in foreign warships built abroad as well as in this country.

It is not proposed to give any facts for these vessels, or to compare them with results obtained by similar classes of ships in the royal navy. Apart from full knowledge of the conditions under which speed trials are made, a mere statement of speeds attained is of no service. One requires to be informed accurately respecting the duration of the trial, the manner in which engines and boilers are worked, the extent to which boilers are "forced," or the proportion of heating surface to power indicated, the care taken to eliminate the influence of tide or current, the mode in which the observations of speed are made, and other details, before any fair or exact comparison is possible between ships. For present purposes, therefore, it is preferable to confine the illustrations of increase in speed in warships to results obtained under Admiralty conditions, and which are fairly comparable.

A great increase in size has accompanied this increase in speed, but it has resulted from other changes in modern types, as well as from the rise in speed. Modern battleships are of 13,000 to 15,000 tons, and modern cruisers of 10,000 to 14,000 tons, not merely because they are faster than their predecessors, but because they have greater powers of offence and defence, and possess greater coal endurance. Only a detailed anaylsis, which cannot now be attempted, could show what is the actual influence of these several changes upon size and cost, and how greatly the improvements made in marine engineering and shipbuilding have tended to keep down the growth in dimensions consequent on increase in load carried, speed attained, and distance traversed. It will be noted also that large as are the dimensions of many classes of modern warships, they are all smaller in length and displacement than the largest mercantile steamers above described. There is no doubt a popular belief that the contrary is true, and that warships exceed merchant ships in tonnage. This arises from the fact that merchant ships are ordinarily described, not by their "displacement" tonnage, but by their "registered" tonnage, which is far less than their displacement. As a matter of fact, the largest battleships are only of about two-thirds the displacement of the largest passenger steamers, and from 200 ft. to 300 ft. shorter. The largest cruisers are from 100 ft. to 200 ft. shorter than the largest passenger steamers, and about 60 per cent of their displacement. In breadth the warships exceed the largest merchant steamers by from 5 ft. to 10 ft. This difference in form and proportions is the result of radical differences in the vertical distribution of the weights carried, and is essential to the proper stability of the warships. Here we find an illustration of the general principle underlying all ship designing. In selecting the forms and proportions of a new ship considerations of economical propulsion cannot stand alone. They must be associated with other considerations, such as stability, protection and manœuvring power, and in the final result economy of propulsion may have to be sacrificed to some extent in order to secure other essential qualities.

Society of Naval Architects and Marine Engineers.

The seventh general meeting of the Society of Naval Architects and Marine Engineers will take place in New York city, at 10:00 A. M., Thursday, Novembe- 16, 1899. Through the courtesy of the President and Managers of the American Society of Mechanical Engineers, the meetings will be held in the Auditorium of 12 West Thirty-first street, the sessions continuing through Thursday and Friday, November 16 and 17. There will be a banquet at Delmonico's at 7 P. M., Friday, November 17. The Council will meet in the regular place on Wednesday, November 15, at 3 o'clock in the afternoon. The list of papers to be read at the meeting is as follows:

THURSDAY, NOVEMBER 16, 1899.

1. Coaling Vessels at Sea.
   By Spencer Miller, Esq., Associate.
2. Causes for the Adoption of Water-Tube Boilers in the U. S. Navy.
   By Engineer-in-Chief George W. Melville, U. S. N., Vice-President.
3. Suggestions as to Improved Appliances for Launching Ship's Boats.
   By John Hyslop, Esq.
4. The Electric Plants of the Battleships *Kearsarge* and *Kentucky*.
   By Naval Constructor J. J. Woodward, U. S. N., Member.
5. The Increasing Complications in Warships, and How Simpler Arrangements Might be Adopted.
   By George W. Dickie, Esq., Member of Council.
6. Beam Formulæ Applied to a Vertically Stiffened Bulkhead, with Some Results.
   By H. F. Norton, Esq., Member.
7. Notes on Sheathing the U. S. S. *Chesapeake*.
   By Naval Constructor Lloyd Bankson, U. S. N., Member.

FRIDAY, NOVEMBER 17, 1899.

8. System of Work in a Great Lake Shipyard.
   By W. I. Babcock, Esq., Member.
9. Overhead Cranes, Staging and Riveter Carrying Appliances in the Shipyard.
   By James Dickie, Esq., Member.
10. Designs for the Denver Class Sheathed Protected Cruisers.
    By Chief Constructor Philip Hichborn, U. S. N., Vice-President.
11. Novelties in Ship Fittings.
    By Assistant Naval Constructor R. M. Watt, U. S. N., Member.
12. Progressive Speed Trials of the U. S. S. *Manning*.
    By Prof. C. H. Peabody, Member of Council.
13. Tactical Considerations Involved in Torpedo Boat Design.
    By Lieut. A. P. Niblack, U. S. N., Associate.
14. On the Action of the Rudder, with Special Reference to the Motion of the Ship While the Helm is Being Put over.
    By Prof. William F. Durand, Member of Council.

It will be recalled that at the last meeting a resolution was adopted inviting papers on the subject of life-saving at sea, and from the papers submitted a selection of two was to be made for reading and discussion.

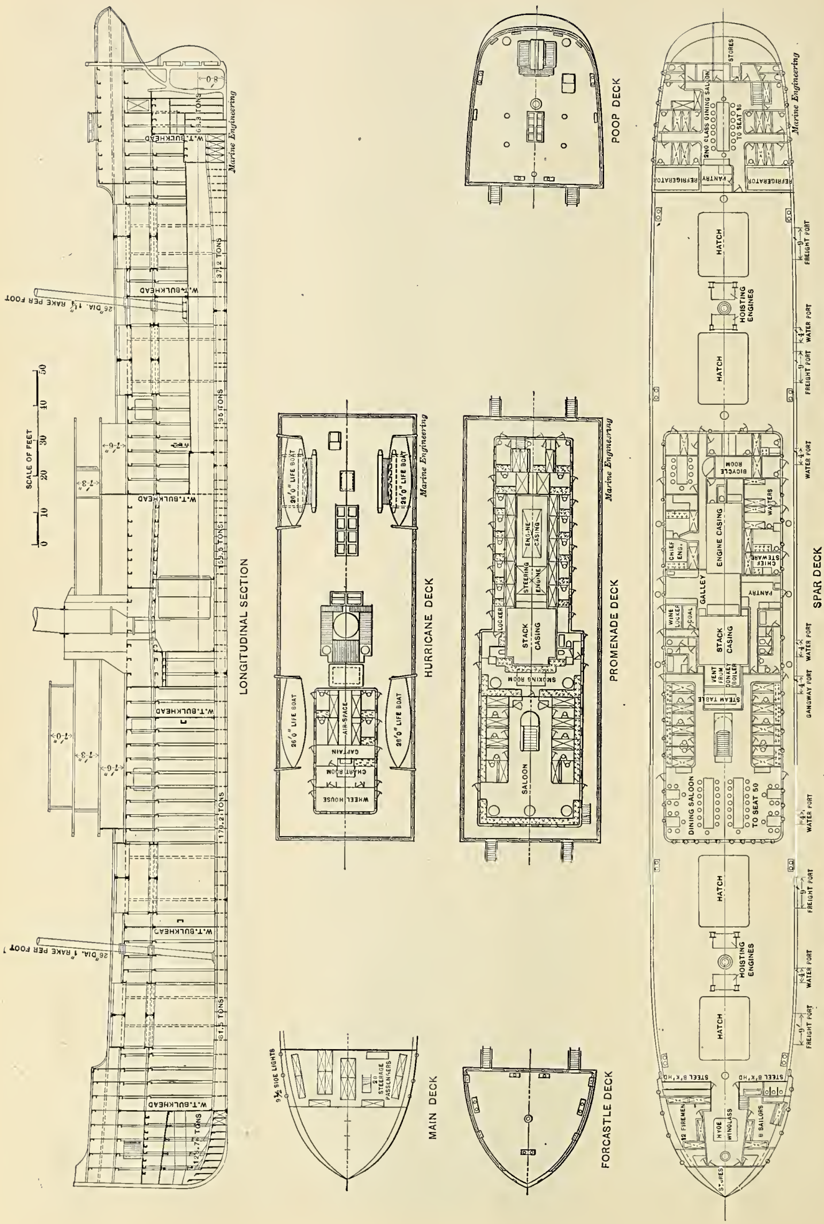
STEAMSHIP PONCE FOR NEW YORK & PORTO RICO S. S. CO., BUILT AND ENGINED BY HARLAN & HOLLINGSWORTH, WILMINGTON, DEL.

STEAMSHIP PONCE FOR REGULAR SERVICE BETWEEN NEW YORK AND PORTO RICO.

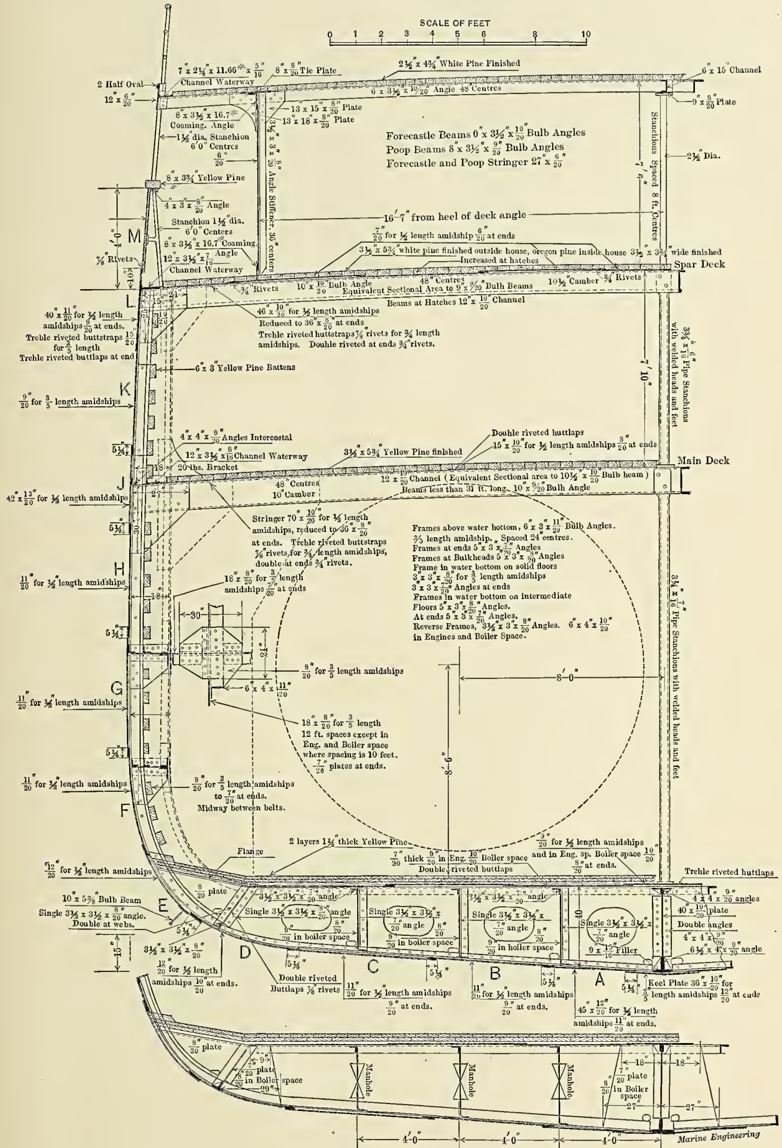
The steamship *Ponce*, recently completed by the Harlan & Hollingsworth Co., of Wilmington, Del., for the New York & Porto Rico S. S. Co., of New York, and which was much in evidence in New York harbor at the time of the Dewey celebration and the yacht races, and on which the Marconi system of wireless telegraphy was first introduced in this country, is one of the large new freight and passenger steamers which have been built as a result of the Spanish-American war. She is to form one of the connecting links with the new possessions in the Caribbean Sea. By those who have examined her, she is conceded to be superior to any steamship of her size, recently turned out here, in her freight and passenger accommodations. The *Ponce* is designed to carry the maximum amount of freight and passengers on a small coal capacity and is of the following dimensions:

Length over all	335 ft. 0 in.
Length between perpendiculars	317 ft. 0 in.
Length on water line	322 ft. 0 in.
Beam, moulded	42 ft. 0 in.
Depth at center to main deck	19 ft. 10 in.
Depth to spar deck	27 ft. 8 in.
Depth at side to spar deck	26 ft. 9 1-2 in.
Depth to main deck at side, moulded	19 ft. 0 in.
Draft, loaded	19 ft. 0 in.
Gross tonnage	3,503 tons.
Net	2,819 tons.
Dead weight carrying capacity	3,250 tons.

The *Ponce* is of the spar deck type, with topgallant forecastle, bridge and poop decks. In the topgallant forecastle are accommodations for the firemen and sailors fitted with pipe berths, also bath room and toilet room, lamp room and carpenter shop. The midship house is of steel and in the forward end of this is lo-



PLANS OF THE NEW PASSENGER AND FREIGHT STEAMER PONCE, BUILT FOR REGULAR SERVICE BETWEEN NEW YORK AND PORTO RICO.



HALF MID-SECTION OF STEAMSHIP PONCE, BUILT BY HARLAN & HOLLINGSWORTH, WILMINGTON, DEL.

cated the dining room, handsomely paneled in quartered oak, with staterooms similarly finished opening out of it, and a very handsome staircase of oak leading to the upper saloon. The bath rooms and toilet rooms are of the newest style of plumbing, finished with tiling. Abaft the dining room are the mail rooms, the galleys and pantries, together with the officers' staterooms. The second class accommodations are in the poop deck house, together with separate galleys, refrigerators and dining room, and while finished plainly, are as comfortable as those of the first class.

Above the midship deck house of steel is the saloon deck house of wood, with smoking room paneled with white maple and staterooms handsomely finished. Above this is the pilot house, chart room and captain's quarters, handsomely finished in hardwood.

The *Ponce* has two electric light plants, with a capacity of about 250 lights (16 c.p.) and all fittings, such as steam heating apparatus, plumbing, are of the newest models.

The engines are triple-expansion with inverted cylinders, with high-pressure cylinder 24 in. dia., intermediate cylinder 38 in. dia. and low-pressure cylinder 42 in. dia., and a common stroke of 42 in. Two single ended Scotch boilers are fitted, each with shell 14 ft. dia. and 12 ft. long. There are six furnaces 48 in. dia., and the boilers are fitted with the Ellis & Eaves equipment for induced draft. A donkey boiler 8 ft. by 9 ft. 3 in. is also included, with all necessary auxiliaries.

The *Ponce* has two steel masts with two cargo booms on each mast, four extremely large hatches and four Williamson double cylinder winches for handling cargo. A Hyde steam capstan windlass is fitted forward and steam capstan aft. She has six watertight bulkheads and an equipment of four 26 ft. metallic life-boats, two 18 ft. metallic life rafts, and the necessary inspection outfits.

She is certainly a great improvement in appearance over the usual type of seagoing American steamer, with excessive shear, attenuated smoke pipe and unsightly, flimsy, tinder box deck houses. The *Ponce* has been built on a guarantee to make 12 knots on 19 ft. load draft on her first trip to Porto Rico. She was built under the supervision of John Haug, Lloyds inspector.

S.S. Ivernia.—The new Cunarder *Ivernia*, building on the East Coast of England, will be one of the largest vessels afloat, although she will not be a record breaker in the matter of speed. This vessel is designed for the Boston-Liverpool route of the company, and has been designed chiefly for the carriage of steerage passengers, freight and cattle, although accommodations for a small number of cabin passengers will be fitted. The dimensions of the new vessel are: Length over all, 600 ft.; beam, extreme, 64 ft. 6 in.; depth to upper deck, 41 ft. 6 in.; gross tonnage 13,900 tons. The vessel will have twin screws, driven by quadruple expansion engines, with cylinders 28 1-2 in., 41 in., 58 1-2 in., and 84 in. dia., and 54 in. stroke. She will have nine single-ended boilers, built to work at a pressure of 210 lbs., and will have a single stack. The vessel was christened by the Countess of Ravenswood. A sister ship, the *Saxonia*, now under construction at Clydebank, has been the subject of many wild rumors as regards size and speed.

CONSIDERATION OF THE STEAM YACHT FROM THE DESIGNER'S POINT OF VIEW.—II.

BY WILLIAM A. FAIRBURN.

Having now rapidly sketched each type of vessel and described representative vessels of each class, let us consider a number of principles involved in steam yacht design. In the design of full powered steam yachts many problems affecting the motive power have to be solved. In the first place we must decide on single or twin screw propulsion. For efficiency of propulsion there is very little difference, the single screw being slightly superior. The twin screw engines have usually the disadvantage of being somewhat heavier than the single screw engine, and they may possibly take up just as much or even more room fore and aft owing to the location of the condenser and auxiliaries aft of the main engines, instead of being placed on the side, as is usual in single screw vessels. This, of course, applies to narrow vessels, such as high speed steam yachts, and the fact of placing both engines as near the center line of the ship as possible has little effect in overcoming the difficulty. By the adoption of twin screws, however, the weight can be put lower in the vessel, as engines of short stroke are usually adopted. The machinery parts are smaller, and in case of accident the vessel has two lives, for in case of one engine breaking down there is still another, and if that remains in good condition one need have no anxiety about reaching port.

Yacht engineers to-day are strongly opposed to high piston speed with a short stroke engine. As a class—of course there are exceptions—they base all their estimates of engine speed on revolutions only, and no matter how short the stroke is they generally insist on keeping the revolutions the same. The only way to get light machinery to-day, besides varying the ratios of cylinders and number of expansions, is by adopting a short stroke and making up the piston speed by revolutions. But this the American engineer is strongly opposed to. The writer strongly advocates as long a stroke as possible in a sea-going ship, but in a high speed yacht a long stroke is impracticable, as it necessarily means a very heavy engine, which again means less coal, stores, and a reduction of freeboard, and the latter feature, if overcome, means increased weight of hull and still less coal and consumable load. The writer recommends the adoption of twin screws for full powered steam yachts with little or no sail spread, but for a vessel with sail as an auxiliary power it seems that a single screw is quite satisfactory and in some respects desirable. If the draught is limited and the speed high it may be necessary to adopt twin screws in order that the propeller shall agree with the speed of the ship and the speed of the engine. The question of weight of machinery is an unusually important factor in steam yacht design. No matter what speed a yacht of a certain type and size may have, the weight of her hull will be practically the same, especially if she is built to conform to the rules of any standard classification society. If any difference exists, the higher the speed the greater will be the weight of hull, owing to the heavier and larger machinery foundations and the extra stiffening and fore and aft members necessary to

give rigidity to the structure and ability to carry heavy concentrated loads. The displacement of a vessel minus the weight of hull and fittings will give us the weight allowable for machinery, coal and stores.

Let it be required to design a full power twin screw steam yacht of about 1,250 tons displacement with a speed of 17 knots. Suitable proportions for such a vessel are: Length to beam, 7.5, and beam to draught, 2.35 or 2.4, and these proportions would give us dimensions: L. W. L., 232 ft.; beam, 31 ft.; draught, 13 ft.; and assuming a block co-efficient of about .47, a displacement of 1,250 tons. Now the approximate weight of hull and fittings complete for such a vessel of the most modern type would be about 600 tons, and thus 650 tons is available for machinery, coal, complement, outfit and stores. The power to drive the proposed vessel at 17 knots speed under favorable conditions at sea will be about 3,400 I.H.P., and two engines to give this power with a stroke of 33 in. and a piston speed of about 800 ft. to 830 ft. will weigh, with shafting, propellers, piping, spares and all auxiliaries, about 220 tons. Therefore we have a weight of only 430 tons for boilers, coal, fresh water, complement, outfit and stores. If the owner insisted on Scotch boilers worked at natural draft we would find that five single ended boilers to give this power—estimating 10 I.H.P. per sq. ft. of grate area—would weigh, steam up and including all fire room weights, about 320 tons, and as fully 70 tons on a coasting or short distance cruiser would be taken up by water, complement, outfit, stores, etc., only 40 tons of coal could be carried on the designed 13 ft. draught. If Scotch boilers are insisted upon it is quite evident that forced draught will have to be used. If we estimate 17 I. H. P. per sq. ft. of grate surface, which can be obtained with a fair air pressure, and without excessive forcing, we can obtain the necessary power with two very large Scotch boilers, which, with water, a small donkey boiler for auxiliary purposes, and all fire room weights complete, will weigh about 220 tons. Therefore, about 140 tons of coal could be carried. This would probably be sufficient for a cruising coastwise vessel, and as she has good freeboard the vessel, if given large bunker capacity, would be able to cross the Atlantic at a much lower speed by leaving port over draught.

Another problem arises if the owner insists on the vessel carrying coal enough to steam across the Atlantic at say 15 knots speed. To do this such a vessel as here described would have to be equipped with water-tube boilers of the express or small tube type, and smaller high speed economical engines bordering on the torpedo boat destroyer type, for the vessel would have to carry over 400 tons of coal to attain the mean speed. It is a well known fact that as the speed of a vessel increases the ratio of length to beam should increase, and the block co-efficient should decrease. But steam yachts are, as a rule, so very fine that the co-efficient of displacement can remain constant as the speed increases without any appreciable increase in wave making resistance. If we keep the co-efficient of fineness of displacement constant, then, as the speed increase of the weight of machinery per I. H. P. must decrease. As it is not desirable in these days to increase the piston speed of an ocean-going cruiser beyond 800 or 900 ft. per minute, the engine room weights cannot be decreased much, and forced draught and water tube boilers become a necessity in order to fulfil the owner's requirements. Forced draught is not always desirable, and many of the latest British built yachts, although credited with a trial speed of 16 to 17 knots, are only capable of maintaining 13 1-2 to 14 knots when running full speed with natural draught, or under full speed cruising condition. The use of forced draught is advantageous, however, aside from the question of weight. Two boilers working under forced draught must necessarily take up much less room fore and aft than four or five boilers working with natural draught. Two large yachts at present building have the same power. One is to obtain the power with natural draught and the other is to use forced draught. If the coal capacity and dimensions of the vessels were the same the total fore and aft length of machinery would be 102 ft. in the natural draught boat, against 86 ft. in the forced draught boat, which means that the vessel using forced draught has 16 ft. more room fore and aft to be used for the accommodation of the owner and his guests.

To obtain high speed in a steam yacht, the owner has to greatly sacrifice comfort and accommodation. A large steam yacht with good sail spread designed for 12 knots speed under steam alone, natural draft, has a length of 60 ft. amidships devoted to machinery and coal. This same vessel to make a speed of 15 knots natural draft requires a length of 100 ft. for machinery, an increase of 40 ft., or almost twice as much length, to obtain 3 knots more speed, the endurance being the same in each case.

A few years ago the term auxiliary steam yacht seemed almost a misnomer, as the steam power was usually capable of driving the yacht at a speed of more than four-fifths that of a yacht of similar size which was provided with full steam power. Of late years the speed of full powered steam yachts has increased remarkably, until to-day 15 to 18 knots for large vessels and 12 to 16 knots for smaller boats has taken the place of the 12 and 10 knots respectively in the older yachts. The finest auxiliary steam yachts of the large type to-day have a speed under steam alone of about 10 to 12 knots; with speeds of 9 to 11 knots for the medium size and smaller vessels. It would be quite interesting if we could tell just how much an auxiliary yacht under steam would increase her speed by using her sail power, or vice-versa. If a yacht can steam at the rate of say 10 knots and if there is a beam wind which would enable her to make the same speed under canvas without steam, then her speed with the use of both steam and sail power will probably be about 12.5 knots. Supposing the speed under sail to be 12 knots and the speed under steam 8 knots, then the speed under sail and steam combined will be approximately a little over 13 knots.

Auxiliary steam yachts should be fitted with feathering screws. Various methods for feathering have been patented, but the one in most general use is that known as Bevis's.

Most auxiliary steam yachts carry ballast, either water in ballast tanks or else lead, pig iron or solid cement between the floors. If one or the other of these methods for increasing stability is not adopted, great care must be taken in proportioning the dimensions of such

a vessel, for the loss of weight of coal and consumable stores may seriously effect the boat under canvas. The coal should also be used from about the fore and aft position of the center of buoyancy, because, if not there will be the difficulty of trim to contend with, which, although it may not be of much consequence to the full powered steam yacht, might be a serious matter for the auxiliary if she had to work against a foul wind.

The remarkable runs of auxiliary yachts, previously cited, shows their great advantage over unsparred vessels, for they can run thousands of miles under sail alone and thus effect a great saving in coal. The auxiliary yacht requires more beam and usually more depth than the full powered yacht, for a good beam is absolutely essential to give the required high metacentre. The spars, sails and rigging of various steam yachts, with sail power, raise the center of gravity of the vessel from 12 to 18 inches; therefore such vessels must be given good deadrise and increased beam to raise the metacentre accordingly. Whereas 15 to 30 in. initial metacentric height is considered sufficient for steam yachts, 30 to 40 in. is generally considered desirable for auxiliary vessels. As a rule the proportions of auxiliary yachts are such as to insure there being better sea boats than the full powered yachts. At low speeds they are also very economical to drive, but their proportions are not as a rule suitable for higher speeds.

There are few high speed full powered steam yachts to-day that carry sufficient canvas to give them fair speed under sail alone, for as before stated, the proportions adopted for one are not suitable for the other. Nevertheless Col. O. H. Payne's new, American designed, steam yacht *Aphrodite,* is a compromise of the two types. Under steam alone she has attained a speed in dead water of 17 1-4 knots, under natural draft. She has a sustained speed of 15 knots, natural draft, and with over 18,000 sq. ft. of canvas she will be able to jog along at a good gait under sail. She is a single screw vessel, 260 ft. long on the water line, 303 ft. over all, 35 ft. 6 in. beam, and 16 ft. draft, and as she has a very good form for her high speed a number of very complex problems had to be considered in her design. She was constructed at the Bath Iron Works, Bath, Me., from their own designs, C. R. Hascom, General Superintendent, and she has the distinction of being the largest and finest American built steam yacht afloat.

About 12 years ago the British yacht *Amy,* 812 tons, owned by N. B. Stewart, was the largest steam yacht afloat. The American yacht *Namouna,* 740 tons, owned by James Gordon Bennett, came next, and closely following in size was the British yacht *Wanderer,* 708 tons, owned by C. J. Lanhert, which vessel circumnavigated the globe and earned quite an enviable reputation as a deep sea cruiser. Late in 1886 W. K. Vanderbilt's palatial yacht *Alva* was launched at Wilmington, Del., U. S. A., and this enormous barkantine rigged vessel of 1,311 tons, until sunk by the S. S. *H. F. Dimmock* in the Sound, was the largest private owned pleasure craft afloat. Mr. Vanderbilt's present magnificent yacht *Valiant,* already described, was built to replace the *Alva.* In 12 years, therefore, the size of the largest steam pleasure craft afloat has increased three-fold. or from 800 to 2,400 tons.

A COMPREHENSIVE ACCOUNT OF THE SUBMARINE TELEGRAPHS OF THE WORLD.

A very interesting account of the submarine telegraphs of the world, prepared by the Bureau of Statistics, U. S. Treasury Department, is of special interest at this time on account of the importance of our trans-Pacific possessions, and for the purpose of information and ready reference we here publish the article in full:

"The submarine telegraphs of the world number 1,500. Their aggregate length is 170,000 miles; their total cost is estimated at $250,000,000, and the number of messages annually transmitted over them 6,000,000.* All the grand divisions of the earth are now connected by their wires, and from country to country and island to island the thoughts and words of mankind are instantaneously transmitted. Beneath all oceans save the Pacific the universal language which this system has created flows uninterruptedly, and man talks as face to face with his fellow-man at the antipodes. Darkest Africa now converses daily with enlightened Europe or America, and the great events of the morning are known in the evening throughout the inhabited world. Adding to the submarine lines the land-telegraph systems by which they are connected and through which they bring interior points of the various continents into instantaneous communication, the total length of telegraph lines of the world is 835,000 miles, the length of their single wires or conductors 3,500,000 miles, and the total number of messages annually sent over them 365,000,000, or an average of 1,000,000 messages each day.

"In the short half century since the practicability of submarine telegraphy was demonstrated, the electric wires have invaded every ocean except the Pacific. Nearly a score of wires have been laid across the Atlantic, of which no less than thirteen now successfully operate between the United States and Europe, while three others span the comparatively short distance between South America and the African and south European coast lines. Throughout the Indian Ocean, lines connect the far East with Europe and America by way of the Red Sea, the Mediterranean, the western coast of Europe, and the great trans-Atlantic lines. The Mediterranean is crossed and recrossed in its entire length and breadth by numerous cable lines, and the 'Mediterranean of America,' the Gulf of Mexico and the Caribbean Sea, is traversed in all directions by lines which bring its islands and colonies into speaking relations with each other and with South America, Central America, the United States, and thence with Europe, Africa, Asia—the whole world. Along the eastern coast of Asia, cable lines loop from port to port and island to island, receiving messages overland from eastern Europe by way of the Russia-Siberian land lines and forwarding them to Japan, China, Australia, New Zealand, the Straits Settlements, Hongkong, and the Philippines, and receiving others in return. South

*Of this total about 150,000 miles belong to 35 companies operating the commercial cables, which number about 320; the remainder are mostly short lines controlled by governments, and connecting forts, batteries, signal stations, light-houses, etc., the aggregate of governmental lines being about 1,150 and their total length about 20,000 miles. In addition to this the governments of the world hold about 80,000 miles of cable in stock for war purposes, ready to be laid at a moment's notice.

America is skirted with cable lines along its entire border save the extreme south, where they are brought into intercommunication by land lines. Along the entire coast of Africa, cables loop from place to place and from colony to colony, stretching along the entire circumference and penetrating the interior by land lines at various points.

"Every body of water lying between the inhabited portions of the earth, with the single exception of the Pacific Ocean, has been crossed and recrossed by submarine telegraph lines. Even that vast expanse of water has been invaded along its margin, submarine wires stretching along its western border from Siberia to Australia, while its eastern borders are skirted with lines which stretch along the western coast of the two Americas. Several adventurous pioneers in Pacific telegraphy have ventured to considerable distances and depths in that great ocean, one cable line running from Australia to New Zealand, a distance of over 1,000 miles, and another extending from Australia to the French colony of New Caledonia, 800 miles seaward.

"The chief obstacle in the past to the construction of a grand trans-Pacific cable was found in the fact that midocean resting places could not be satisfactorily obtained or arranged for, no single government controlling a sufficient number of suitable landing places to make this seem practicable, in view of the belief that the distance through which messages could be sent and cables controlled was limited. With landing places at Hawaii, Wake Island, Guam, and the Philippines, however, no section of a cable stretching from the United States to Asia and touching at these points would have a length equal to that now in daily operation between France and the United States. The length of the French cable from Brest, France, to Cape Cod, Mass., is 3,250 miles, while the greatest distance from land to land on the proposed Pacific route would be that from San Francisco to Hawaii, 2,089 miles, that from Hawaii to Wake Island being 2,040 miles, from Wake Island to Guam 1,290 miles, from Guam to Manila 1,520 miles, and from Manila to the Asiatic coast 630 miles. While the depth of the Pacific is somewhat greater than that at which any cable has been laid, the difference between its depth and the greatest reached by cables in the Atlantic would be very slight, the cable recently laid from Haiti to the Windward Islands being in 18,000 feet of water, while the greatest depth between San Francisco and Hawaii is 18,300 feet, and the greatest depth between Hawaii and Manila is estimated at 19,600 feet, though this estimate is yet to be verified by detailed soundings. Otto Krummel, who was the first to discuss the bathymetric data and calculate the area and volume of the various oceanic basins, puts the mean depth of the Pacific at 2,160 fathoms, against 2,040 for the Atlantic, in which cables have already been so successfully laid, and later researches and actual soundings, while they have developed extreme depths at certain points in the Pacific, have not, in the opinion of experts, been such as to warrant the belief that the depths along the proposed line would be considerably greater than those in which cables have been already successfully laid and operated.

"The developments in the construction, laying, and operating of submarine cables and in their availability for general public use have quite kept pace with their extension throughout the civilized world. From a mere gutta-percha-coated wire, the submarine conductor of electricity has developed in a half-century into a great cable having a central copper core surrounded by numerous layers of non-conducting material and protected by steel wire wound spirally about it, and in turn further protected by waterproof and insect-proof wrappings. From a steamer-towed open barge, the facilities for laying have developed to a fleet of nearly fifty steam vessels, with every facility for laying, picking up, splicing, and repairing the cable lines. From a speed rate of three words per minute, which was made on the first transatlantic cables, the speed of transmission has been accelerated to fifty words per minute, and even more than that with the automatic transmitters now coming into use with cable lines, while by the duplexing of the cables their carrying capacity is doubled. From a cost to the sender of $100 per message, which was originally charged on the first transatlantic cables, the rate from New York to London and the great cities on the continent of Europe has fallen to 25 cents per word. From several hours required for the transmission of a message and receipt of a response, the time has been so reduced that messages from the Executive Mansion to the battle-field at Santiago were sent and a response received within 12 minutes, while a message sent from the House of Representatives in Washington to the House of Parliament in London in the chess match of 1898 was transmitted and the reply received in 13 1-2 seconds.

"The effect of this ready and inexpensive method of transmitting thoughts and words from continent to continent throughout the civilized world is shown in the rapid development of international commerce since it began. The first successful cable lines between the United States and Europe were put into operation in 1866. In that year our commerce with Europe amounted to $652,232,289; in 1876, to $728,959,053; in 1886, to $898,911,504; in 1896, to $1,091,682,874, and in 1898, to $1,279,739,936, while our commerce with the whole world, which in 1866 amounted to $783,671,588, had by 1898 reached the enormous sum of $1,847,531,984.

"With this evidence of the advantage of prompt communication between commercial centers desiring an interchange of their products, it may not be improper to call attention to the fact that the United States now obtains but a small proportion of the commerce of Asia, which it is at present only able to reach through the long and devious submarine and land telegraph lines across the Atlantic, the continent of Europe, the Mediterranean, the Red Sea or the Persian Gulf, the Indian Ocean, land lines across India, cable lines again by way of the Straits Settlements, and thence along the Asiatic coast and among the islands of Oceanica. The commerce of the countries of Asia and Oceanica lying commercially adjacent to the Philippine Islands amounts to more than $2,000,000,000 annually, their imports alone averaging $100,000,000 a month, or $1,200,000,000 per annum. Of this enormous market the United States at present obtains less than 6 per cent, despite the fact that the imports into the countries in question are largely composed of the classes of arti-

cles produced in the United States and offered for sale by her manufacturers and merchants. With a direct cable communication across the Pacific, direct water communication through a Nicaraguan canal, and an increase in the number and capacity of American steamships, it seems not improper to suppose that a material addition might be made to the share obtained by the United States in the trade of that part of the world."

Atlantic Liner Kaiser Friedrich.

Flying the house flag of the Hamburg-American line the magnificent new liner *Kaiser Friedrich* came into the port of New York recently, and after the usual stay took on passengers and cargo and sailed on schedule on her return trip October 17. No speed records were broken coming over, nor does it seem likely that any will be by the new vessel. We used the adjective (magnificent) advisedly, for taking the vessel as a whole in comparison with other liners she is truly a magnificent ship. That she has not come up to expectations is due, in great part, to what might at first seem to be details not of the first importance. In fact this vessel is an example—not the first by any means—of what may be gained or lost by the treatment of details of design.

The *Kaiser Friedrich*, as most of our readers are doubtless aware, was built at Elbing for the North German Lloyd Co., and made her first trip in the summer of 1898. She had had no trial at sea before starting on her maiden voyage, and her time across was very disappointing to the company for which she was built. Owing to defects which developed in the machinery the vessel had to be slowed down the greater part of the voyage, and her average speed across was less than eighteen knots. At the time we published an account of this trip, and referred in detail to the causes of delay. These were not due to imperfect workmanship or material, but to fundamental features of design in the machinery equipment. The North German Lloyds finally returned the vessel to the builders, and are understood to have subsequently offered a price for the vessel which the builder would not accept. Other offers were made for the liner, and finally she was acquired by the Hamburg-American line at a price which is said to have been close to 7,500,000 marks. The terms of the sale have not been announced, but the vessel is reported to have been taken over on a guarantee.

S. S. KAISER FRIEDRICH FLYING THE FLAG OF THE HAMBURG-AMERICAN LINE.

When the *Kaiser Friedrich* came out she was fitted with air pumps driven direct by the main engines. These were removed and independent air pumps substituted. Provision was also made for additional receiver space in the engines by the attachment of outside receivers on top of the cylinder castings. In this way the difficulties in the engine room were gotten over. The difficulty of holding steam at the working

pressure was sought to be overcome by removing the original boiler tubes, which were bottle-necked in the back connections, and substituting for them tubes with coned ends. A change has also been made in the system of draft, and, instead of forced draft, natural draft will probably be employed hereafter.

This is not the first instance in which a liner built for one line was afterward transferred permanently to another, and while the *Kaiser Friedrich* will not likely be classed as a flyer, she ought to find a top place in the 19-knot class. She will still be a fast boat, and as she was built primarily for passenger service—the cargo-carrying capacity being extremely small—and fitted up luxuriously with every possible device for the comfort and convenience of ocean voyagers, she is likely to become a favorite. To many indeed it would be a source of satisfaction that they were traveling in a boat that was not being driven to the utmost limit.

For convenience we repeat her dimensions, as follows: Length, 600 ft.; beam, 64 ft.; depth, 41 ft. from keel to upper deck; gross tonnage, 12,000 tons; and displacement at 28 ft. draught, 17,000 tons. The fine appearance of the *Kaiser Friedrich* at sea is shown in the accompanying reproduction of a recent photograph.

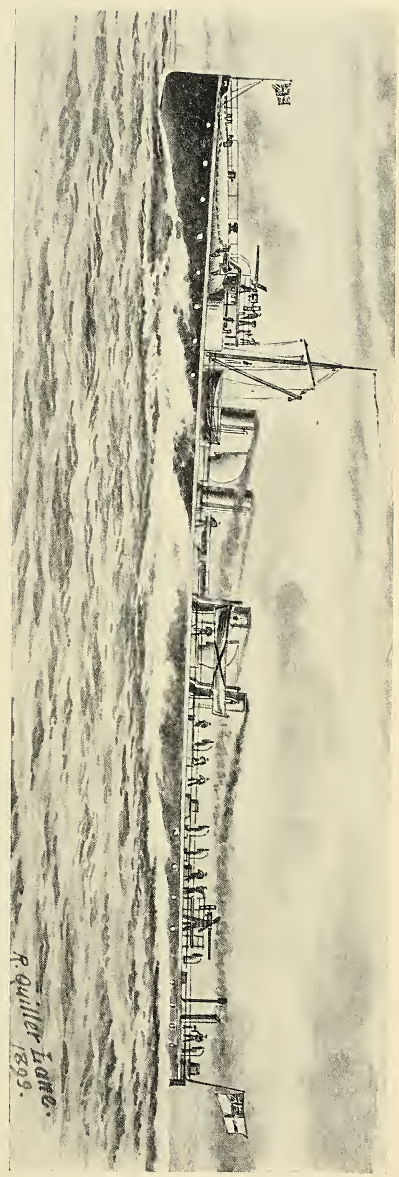
H. M. S. Viper—Turbine Driven Destroyer.

In our last issue we gave an account of the progress which has been made in the application of Parsons' steam turbine to marine propulsion, and referred to two torpedo boat destroyers under construction in England to be fitted with the turbine form of propelling engines. One of these boats is for the British navy, and is named the *Viper*. She was launched September 6 from the works of Hawthorne, Leslie & Co., Newcastle-on-Tyne, and we are now enabled to present a sketch of the new flier as she will appear at top speed—this is given as not less than 35 knots. The exact dimensions of the vessel are not yet public property. She will displace, however, about 325 tons, and her builders report that the engines are expected to develop about 12,000 horse power. She will have four sets of propelling turbines, and four separate shafts, with two propellers on each shaft. Following are the weights which have been announced: Engine room, 117,152 lb.; boiler room, 225,680 lb.; shafting, 17,360 lb.

A lower estimate for the power is apparently made by the British naval authorities, for in a paper read by Sir William White, Chief Constructor of the British navy, before the famous British Association, he refers to the boat in these terms:

"The experiment which the Admiralty is making is not on a small scale as regards power. Although it is made in a destroyer, about 10,000 horse power will probably be developed, and a correspondingly high speed attained. It may well happen that from this experiment very far reaching effects may follow."

Should the *Viper* attain a rate of speed of 35 knots this would only equal the results claimed by Schichau, the German builder, who reported a speed in excess of 35 knots, with reciprocating engines, in the case of the four destroyers (200 tons disp., 6,500 I.H.P.) for the Chinese Government. Our readers will recollect that we published in our issue of March last a view of one of these torpedo boat destroyers steaming at top speed.



SKETCH OF H. M. S. VIPER, TURBINE DRIVEN DESTROYER, BUILT TO STEAM AT THE RATE OF 35 KNOTS—DISPLACEMENT, 325 TONS; I. H. P., 10,000.

APPLICATION OF THE THREE-WIRE SYSTEM TO MARINE ELECTRIC PLANTS.

BY CECIL P. POOLE.

The existing absurdity of two "standard" voltages, incommensurate with each other, for marine electric lighting and power plants has been the object of considerable comment, now mildly critical, again timidly argumentative, but the writer has not seen any definite, clear-cut suggestions for a logical standard to supplant the two now in use. As the question is a perfectly simple one, involving only a few considerations based upon well-known and firmly established engineering principles, it seems rather remarkable that the present anomalous state of affairs has survived so long, and yet more remarkable that no one has taken action, at least on paper, toward a reform.

Two opposing conditions control the matter: The electromotive force of a marine system cannot be very high because of the difficulty of permanently insulating the conductors and their inaccessibility on shipboard; and also because there is a well-defined limit to the economical voltage of incandescent lamps; on the other hand, very low potential, such as 50 volts, involves excessive outlay for conductors, because their weight increases as the square of the voltage decreases, for a fixed load in watts, distance in feet and percentage of "drop" in the wiring. Thus, if C represents the load in amperes; W the load or rate of work in watts; E the electro-motive force of the system; F the distance from end to end of a feeder, in feet; V the drop in volts and d the diameter of the wire in mils, we have the following relations:

$$\frac{21.2\,CF}{d^2} = \frac{21.2\,WF}{Ed^2} = V.$$

and as the drop in percentage is $\frac{100V}{E} = D\%$,

$$\frac{2120\,WF}{E^2d^2} = D\%.$$

and consequently, $\frac{2120\,WF}{E^2D\%} = d^2. \therefore d^2 \propto \frac{1}{E^2}$.

As 125 volts is a standard figure for shore apparatus, and generators, motors, lamps, etc., made for this potenial are purchasable in open market, this seems a rational standard for marine work. The insulation of conductors distributing current at this pressure is a simple, every-day problem, even when the wires are located in damp places. For ordinary marine plants, a generator giving 125 volts at the bus bars and supplying a wiring system at a "drop" of 5 volts, leaving 120 volts available at the load, is as near ideal as one can expect perverse inanimate things to approach.

Leaving aside the gain in cost of conducting system that is afforded by 125 volts electromotive force as compared with 80 volts, the former standard has everything in its favor with the bare exception of its application to searchlights.

Should there be several arc lamps in service, requiring individual control, these can be provided for by running three-wire circuits from the nearest convenient point on the main circuit, or from the switchboard, balancing the two sides of the three-wire circuit by means of two motors coupled rigidly as to shafts and connected in circuit, as shown by Fig. 1. The motors have differential field windings, the series coils, S_a, S_b, being connected in opposition to the shunt windings F_a and F_b. These latter are connected each in shunt to the other's armature and series coil. The action is as follows: As long as the load is equal on both sides of the three-wire system the two motors run light. Should the load in a increase beyond that in b, the voltage will drop slightly at the terminals of Fb, causing B to speed up and drive A as a dynamo, restoring the E.M.F. This effect is enhanced by the heavier current from a flowing across from the neutral to b through the demagnetizing field coil Sb, still further weakening the total field of B and increasing its speed.

This action is entirely automatic, either motor speeding up and driving the other as a dynamo the instant the E.M.F. drops on the opposite side. This arrangement is by no means complicated, and can hardly be called "special" now-a-days. Motor dynamos in all sorts of combinations are available and sufficiently

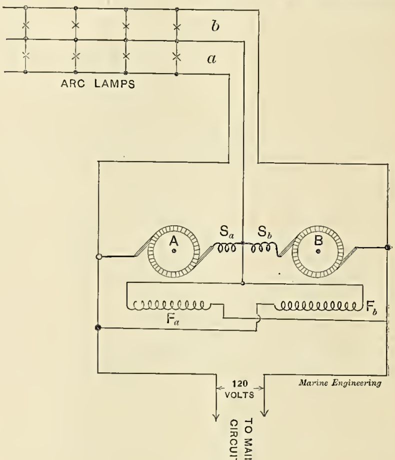


FIG. 1.

common to preclude the imposition of a "fancy" price for two machines of identical design, as here described. This arrangement would give each arc lamp circuit 60 volts potential, which is an economical figure and eliminates all wasteful resistance, except that actually necessary in order to cause the arc to burn steadily on a constant-potential circuit. In the event that there is only one arc lamp—a search light—aboard, then it will be more economical, all things considered, to simply connect it across the 120-volt circuit in series with dead resistance than to either use a low potential plant or put in a motor-dynamo and convert the E.M.F. to 60 volts, as suggested recently by another writer.

Where the plant is of some magnitude the writer would strongly advocate the use of a 250-volt dynamo in connection with a complete three-wire system throughout the ship, with a drop of 10 volts in the outer wires—5 volts in each. It is very little more trouble to insulate 250 volts than to insulate 125 volts, and when

electric motors are used to drive auxiliaries, or even if there is not a motor aboard, and the lighting plant comprises 1,000 lamps or more, the higher potential is immeasurably preferable. A favorite argument against the three-wire system for ship work is the alleged increase in complication. This is a perfectly specious plea; if there is anything that is more complicated in continuous-current work than some of the switchboard arrangements now in use aboard ship, the writer hopes to be spared a struggle with it.

The two sides of the three-wire system may be balanced in a diversity of ways. The two-motor arrangement shown in Fig. 1 may be used in the dynamo room between the main dynamo and the switchboard. Or two ordinary dynamos driven by an engine common to both may be connected with the main 250-volt dynamo, as shown by Fig. 2. These can be each of one-fifth to one-fourth the size (output) of the main dynamo if the plant is properly laid out.

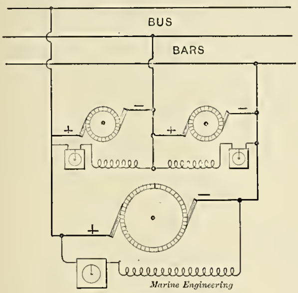


FIG. 2.

A third plan, and one that the writer greatly prefers, is to employ an ordinary four-pole generator with the field windings divided into two separate circuits, and so connected up that the polarity of successive magnet poles does not alternate regularly, in the ordinary manner, but is distributed as in Fig. 3, with the two "north" poles next each other and the two "south" poles given a similar relation. The armature must have an ordinary multi-path Gramme winding and four brushes, and the circuits would be connected as in Fig. 4. Half of the field windings (the coils on one north pole and one south pole) would be supplied from one side of the three-wire system and the other half from the other side, and each would have a rheostat in series with it for regulation purposes.

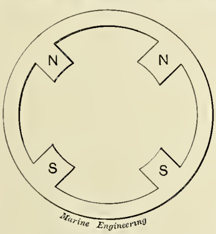


FIG. 3.

Then the rheostat, R_a, would regulate the pressure across from n to a and the rheostat, R_b, would regulate that across from n to b, each entirely independently of the other. And the machine could be compounded just as an ordinary dynamo would be, the series coils on the right-hand pair of poles being in series with b and those on the left hand pair of poles in series with a. In short, each half of the machine will act exactly as a separate dynamo with relation to the other half and the circuit, under normal working conditions, irrespective of the ratio between the two loads.

This arrangement divests the three-wire system of what little "complications" it usually involves—the use of two dynamos (and usually two engines) for all loads, however small—and makes an electromotive force of 250 volts entirely practical without departing from the common staple type of equipment which is found in daily use everywhere. Lamps, sockets, switches and other fittings of standard types are available for use on each side of the system, and a high economy in wire is obtainable without any sacrifice in convenience of control or an appreciable complication.

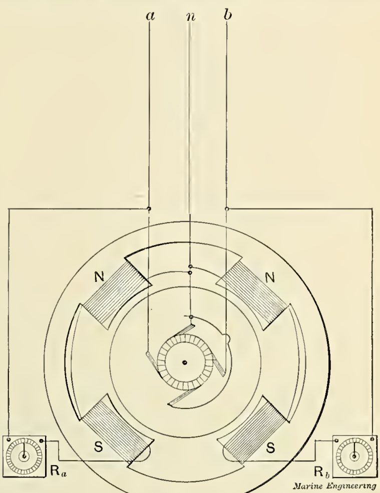


FIG. 4

The same arrangement of the dynamo connections could be applied to a 125-volt system having arc lamps connected in, by using the two outer wires as the regular circuit everywhere except at the arc lamps. A middle wire would be run out to these, as shown in Fig. 5. Pilot wires would extend from the switchboard to the ordinary center of distribution, and a volt meter of 125 volts range or over would be supplied by these; other pilot wires would connect the three-wire group with two voltmeters, each of 75 volts range or over. Once the dynamo is brought up to the proper E.M.F., further hand regulation will be unnecessary, if the machine is properly compounded. In the event that the arc lamps were used intermittently and a plain shunt

wound generator employed, the arrangement shown by Fig. 6 would render regulation more convenient. With the arc lamps out of service the potential would be regulated by means of the rheostat, *R*. When the arc lamps were in service the rheostats *Ra* and *Rb* would

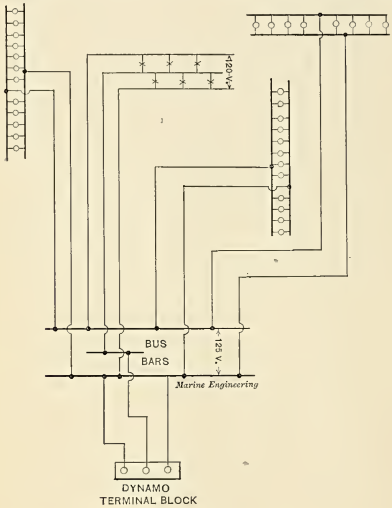


Fig. 5.

have to be used, each to regulate for its own side of the arc lamp wiring. The middle rheostat, *R*, would then not need to be touched.

In case search lights or other arc lamps were to be

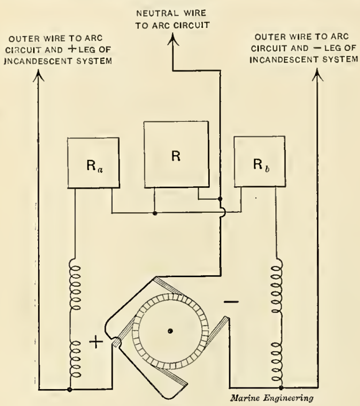


Fig. 6.

used on the 250-volt three-wire system, shown by Fig. 4, a combination of this and the balancing system in Fig. 1 would afford all necessary flexibility. Fig. 7 shows the elements of such a combination system. The arc lighting mains with the balancing motors form a complete sub-system which may be connected with the main system on either side of the neutral wire and at any point. It would be manifestly better engineering to carry the leads *a* and *b* all the way back to the switchboard, where they could be connected and disconnected to and from the bus bars at will.

The conductors for a system such as those shown by Figs. 1 and 5, the dynamo E.M.F. being 125 volts and the drop 4 per cent would cost just 45 per cent of the amount required for conductors in an 80-volt two-wire system under identical conditions, so that the saving in cost of copper would much more than pay for the balancing motors in Fig. 1, if the plant were of any magnitude. The conductors for a system like Fig. 7 would only cost *one-sixth* as much as those for an 80-volt system, including the neutral wire, which is assumed to have a cross section equal to that of each outer wire. Besides this saving there is the further

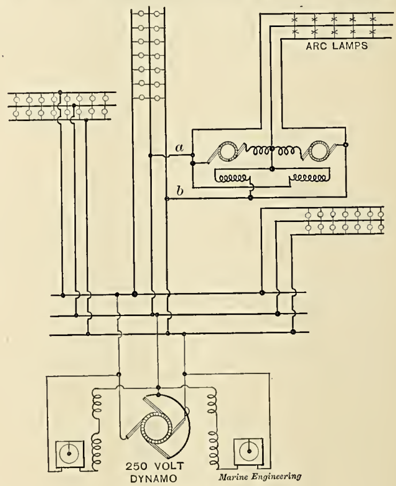


Fig. 7.

advantage that no dead resistance other than that necessary for regulation is required in series with the arc lamps in any of the systems here proposed, whereas in the 80-volt system there is a dead loss of from 25 per cent to 35 per cent due to resistance coils which must be employed to cut down the electromotive force.

Lieutenant Poundstone, U.S.N., has been placed in charge of the naval exhibits at the Paris Exposition. The U.S.S. *Prairie* will leave about the middle of this month for Havre with a number of exhibits which are to be made by the United States Government. One of the chief exhibits of the Navy Department will be a model of the battleship *Maine*.

It is reported that a corporation to be known as the Buffalo Dry Dock Co. has secured control of the Mills Dry Dock Co., Buffalo, and will establish there a plant capable of building large lake steamships.

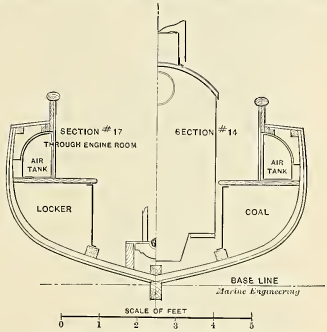
Recent Steamship Losses by Fire.

Fire destroyed the small wooden propeller *Nutmeg State* in Long Island Sound early on the morning of October 14, and about a dozen persons lost their lives. The vessel belonged to a line trading between Bridgeport, Conn., and New York. The boat was about five miles from Execution Light when fire was discovered in the vicinity of the base of the stack. The passengers were at once aroused and the crew set to work to extinguish the flames, but to little purpose. When it was apparent that the vessel could not be saved the boats were ordered lowered. Due to the excitement and terror of the passengers, and the probable unfamiliarity of the deckhands with rescue work, all semblance of discipline was lacking, and boats were capsized. Fortunately at this time the Hartford Line steamer *City of Lawrence* and the steam yacht *Kismet* had sighted the burning vessel, and, coming up, saved many lives. Those taken on board these vessels were treated with great kindness. It was then decided to try and beach the *Nutmeg State*, and the engineers and firemen remained on watch until the vessel touched bottom at Sands Point, Long Island. Their devotion to duty under the circumstances deserves recognition. Charges of cowardice against the crew were made by some passengers and denied by others. The facts go to show that they acquitted themselves well to the best of their ability, and the criticisms made doubtless came from persons who at the time were too excited to form any correct judgment. The *Nutmeg State* was about 200 ft. in length and 100 tons gross tonnage.

After reaching her dock in the East River, New York, from Galveston, Texas, with a cargo of cotton and jute, the Mallory Line steamship *Leona* was found to be on fire. She had come in with passengers, who were landed shortly before the flames appeared, and then the New York fire department was summoned. Water was pumped into her holds until she listed over to starboard and sank to the mud bottom. This vessel is apparently a hoodoo, having had a somewhat similar experience in May, 1898, when on a voyage to Galveston. On that occasion several steerage passengers were burned to death. The vessel will be raised and repaired.

Steam Tenders for Army Transports.

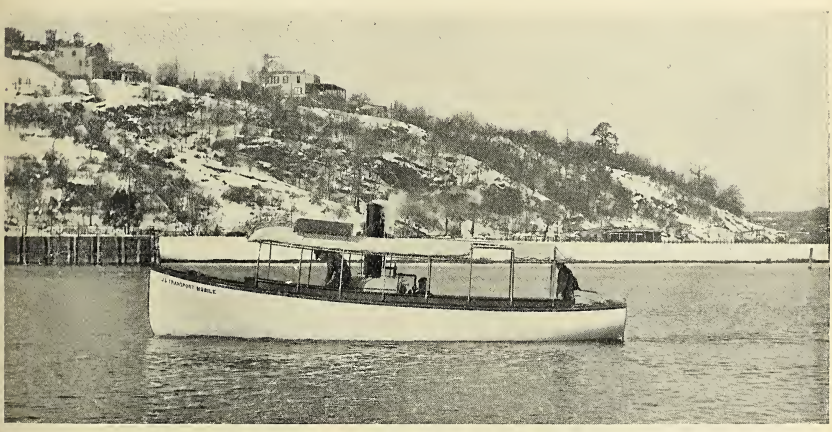
When fitting out the fleet of ocean transports for the United States Army Transport Service, the authorities



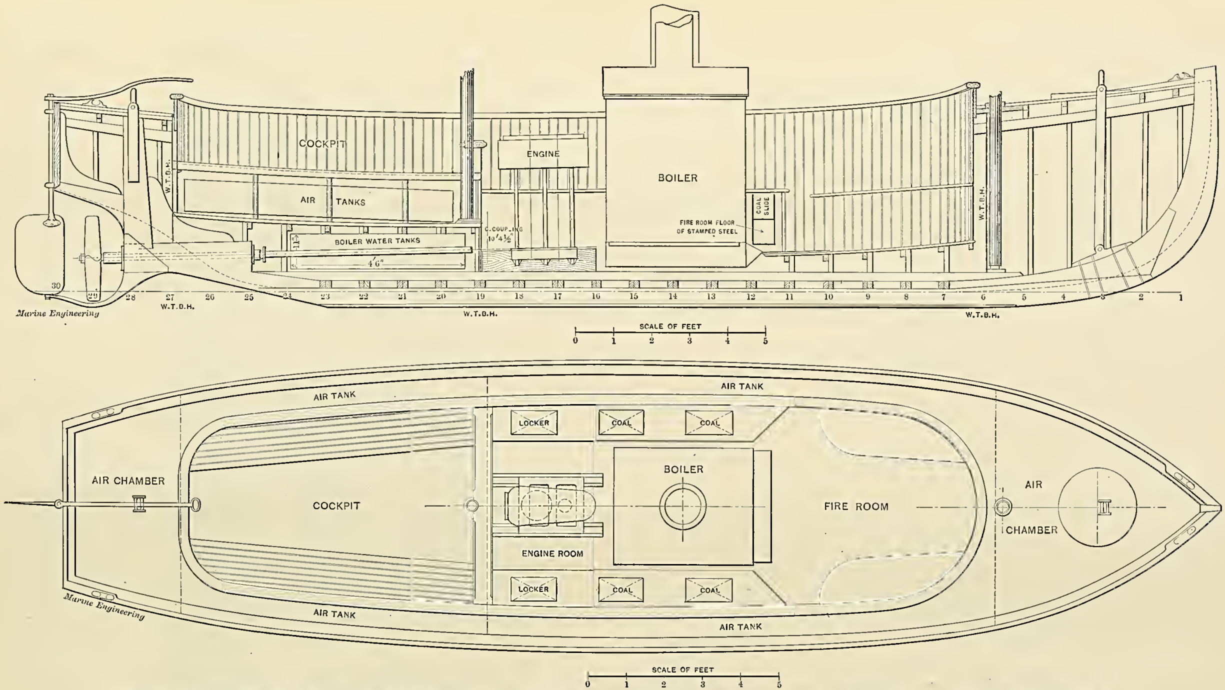
CROSS SECTIONS TRANSPORT TENDERS.

decided to equip the vessels with powerful steam tenders. An order for a number of these boats was accordingly placed with the Gas Engine & Power Co., and Charles L. Seabury & Co., Consolidated, Morris Heights, New York city, and by the courtesy of the builders we are able to here present drawings and photographs of the type.

Details of construction can readily be gathered from an inspection of the accompanying scale drawings. The over-all dimensions are: Length, 30 ft.; beam, 8 ft.; depth, 4 ft. 1 in., and draught, mean, 2 ft. 2 in.

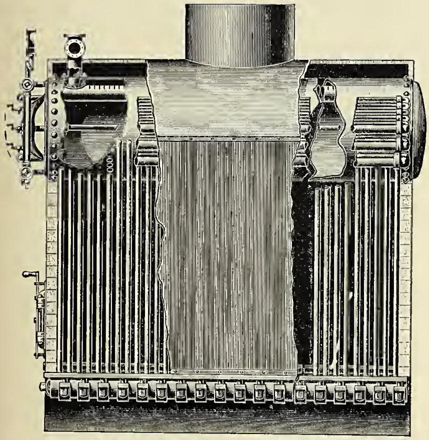


TYPE OF STEAM TENDER ADOPTED FOR U. S. ARMY TRANSPORT SERVICE.

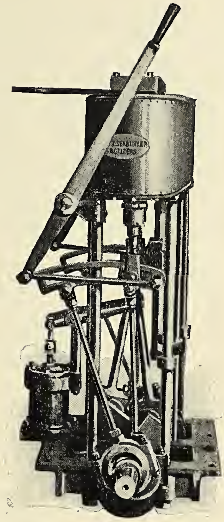


SCREW STEAM TENDERS FOR U. S. ARMY TRANSPORT SERVICE, BUILT BY THE GAS ENGINE & POWER CO. AND C. L. SEABURY & CO., CON., MORRIS HEIGHTS, N. Y.

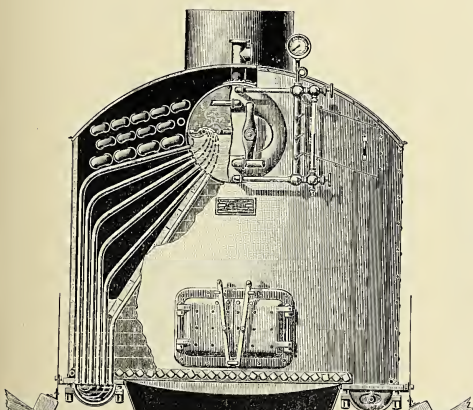
They are fitted with three watertight bulkheads, and are made exceptionally strong, the models being especially adapted for sea-going qualities, with good depth, beam and full lines throughout. The machinery includes a vertical fore and aft compound engine of the builder's standard pattern, with cylinders, 4 in. and 8 in. by 7 in. stroke, and a high-pressure Seabury water-tube boiler. The power is greater than is usually placed in a hull of these dimensions. On the forward deck there is a foundation where a one-pounder rapid fire gun can be mounted. It will be noticed that air tanks are fitted fore and aft for buoyancy, and masts are provided for a lug rig. The boats were built to withstand very rough service, and we are informed that they have given very great satisfaction to the transport service.



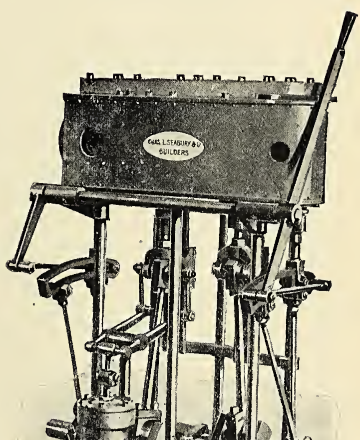
SIDE ELEVATION—CASING PARTLY REMOVED.



END ELEVATION.



WATER TUBE BOILER.



COMPOUND ENGINE.

MACHINERY OF THE SCREW STEAM TENDERS FOR U. S. ARMY TRANSPORT SERVICE.

RESUME OF THE LAKE FREIGHT SITUATION—CAUSES AND EFFECTS.

A most remarkable condition of affairs has come into existence within the past few months in the vessel and shipping business on the Great Lakes. The unusual activity in all branches of business, following on several years of depression, coupled with the almost universal tendency for consolidation in all of the leading industries, and, in the cases of the iron and steel industries, for the manufacturer to own and control his product from the mine to the finished article, has worked such wonderful changes in the transportation end of the operation that what the final results will be the most experienced cannot predict.

The vessel business on the Lakes has been carried on for the past few years on the very scantiest of margins. At the opening the present season's navigation promised nothing out of the ordinary, but as the miners of iron ore held off from selling their 1899 product until an unusually late date, all owners of "wild" tonnage grew uneasy and were very prompt to close early contracts at 60 cents a ton from the head of the Lakes to Lake Erie ports. As a consequence a large number of boats were tied up for the season by charters on this basis. This charter price was established by a deal entered into between the Oliver Mining Co. (Carnegie interests) and the Rockefeller interests, in which the Oliver Mining Co. leased certain mining properties from Rockefeller for a term of fifty years on a fixed royalty, and with an agreed minimum yearly production of about 1,400,000 tons of ore, which they bound themselves to transport over railroads and in vessels controlled by the Rockefeller interests. The rate for this transportation was to be fixed at the starting of each season by agreement if possible, or, if an agreement could not be arrived at, then to be determined at the close of the season by reference to the average price paid by other shippers during the season. Very shortly after the opening of this season's navigation, however, the entirely unlooked for demand for finished iron and steel products, also the consolidation of such interests as have made up the Federal Steel Co., the American Steel & Wire Co., the Republic Iron & Steel Co., and others, and the very sharp advance in prices all along the line changed the conditions materially, and those vessel owners who had not tied up their boats with contracts early in the season began to stiffen up on charter prices and to make larger profits than they had known in years. As a part of the consolidations referred to, the Federal Steel Co. and the American Steel & Wire Co. acquired large mining interests, and at about the same time the Oliver-Carnegie interests also acquired additional large mining properties.

It very soon became apparent to all the larger manufacturers of iron and steel, that if they wished to properly protect their interests they must not only control the blast furnaces and mills, but they must also control the mines and the transportation from the mines to the furnaces. As stated, the Federal Steel Co. already controlled large mine interests, and they also owned, through the Minnesota Steamship Co., a fleet of about sixteen vessels. This fleet was insufficient to handle either the output of their mines or the requirements of their furnaces, and the company promptly placed an order with the Chicago Shipbuilding Co. for a steamer and two tow barges of the largest type. This was followed, very shortly, by the purchase, by the same corporation, of two large steamers then under construction at the Lorain yard of the Cleveland Shipbuilding Co. for A. B. Wolvin and others, and by the sale of the S.S. *Clarence A. Black*, just finished at the same yard, to Pickands-Mather & Co. (representing the same interests), all at considerable advance over the original contract prices of the vessels.

At this time there was sharp competition between the Federal Steel Co. interests and the American Steel & Wire Co. for the control of the fleet of five large steamers owned and operated by the Zenith Transportation Co. Finally the American Steel & Wire Co. succeeded in buying the boats at an advance of 25 per cent over their original cost. About this time it was rumored that Mr. Wolvin, who had built and managed the Zenith Transportation Co.'s fleet, was about to leave the Great Lakes, and, in company with James J. Hill, of the Great Northern Railway, would establish a new trans-Pacific steamship line. This, however, was very shortly proved to be incorrect by the fact that Mr. Wolvin resumed the management of the Zenith fleet for the American Steel & Wire Co., and by his placing an order with the American Ship Building Co. (the new consolidation of Lake shipbuilders) for four 500 ft. steamers, the first of this size to be built on the lakes—these boats being presumably also for the American Steel & Wire Co. interests. Almost at the same time the Bessemer Steamship Co. (Rockefeller interests) again entered the field, as builders, by placing an order for a steamer and two tow barges of the largest type. Mitchell & Co., individual owners, also placed orders for three steamers, each to have a carrying capacity of over 5,000 tons.

These moves, coming as they did in rapid succession and tending to concentrate the tonnage in the hands of a few large ore shippers, left the smaller shippers in an unlooked for predicament, as some of them had a considerable amount of tonnage to be moved, and as the demand for tonnage in other lines of traffic had become unusually sharp. The fierce scramble for boats that ensued was unprecedented, and rates advanced steadily until the almost prohibitive rate of $2.00 a ton on ore from the head of the Lakes to Lake Erie ports was reached. This remarkable advance was not confined to ore rates alone, but was reflected in all lines of shipping, and especially so in grain and lumber rates, and so stimulated vessel values that many boats have since changed ownership at prices quite unlooked for early in the season—and by many never looked for again on the Lakes.

Some of these changes have, indeed, been quite remarkable: for instance, the S.S. *Clarence A. Black*, previously referred to, was built under contract for Detroit parties for $210,000. When completed she was immediately sold at an advance of $30,000, and has again changed hands recently at a price in the neighborhood of $325,000. The S.S. *Angeline*, only recently completed at the Wyandotte yard, changed hands when only about one-third built, at a substantial bonus to her owners, and the same parties who sold her have since contracted for two more vessels at prices considerably in advance of what they received for the *Angeline*.

So much for what has led up to the present situation; now what of the present conditions and of the future? The question is a difficult one, and the battle now on is between giants. As previously noted, the early arrangement made between the Carnegie-Oliver interests and the Rockefeller interests provides for the carrying of about 1,400,000 tons of ore annually for the Carnegie people, by the Rockefellers, at a rate to be adjusted each year, and the rate for the present year was fixed early in the season under the most unpromising conditions. It is, of course, to the interest of the Rockefellers, who own mines and vessels, but do not manufacture, to keep transportation rates up to the highest point, especially during the life of their agreement with Carnegie; while on the other hand it is to the interest of the Carnegie iron masters, with their mines and mills, to keep the cost of transportation down to the minimum. The twenty-four vessels owned by the Rockefellers have an annual carrying capacity of about 2,400,000 tons, considerably more than enough to cover their Carnegie obligations, though not quite enough to carry all the ore produced from the Rockefeller mines, and far from enough to carry the remainder of the 4,500,000 to 5,000,000 tons which it is estimated Carnegie will use during the coming year.

It is still earlier than usual for the chartering for next season, but as soon as the situation here described begin to be realized there was immediately started a sharp competition between these two giant interests to control the vessels necessary to cover this remainder of the Carnegie ore. For weeks past all sorts of rumors have been in circulation of sales of vessels at fabulous prices and of charters for the season of 1900 at unheard of rates. Some of these rumors have, however, become known facts. The Rockefeller interests, after the sharpest competition, have secured by actual purchase the entire American Steel Barge Co.'s fleet of thirty whaleback vessels, with an annual carrying capacity of about 1,500,000 tons. These interests have also secured by charter for the season of 1900, at a rate of $1.25 per ton, eight vessels owned by Mitchell & Co., with a carrying capacity of about 960,000 tons in a season, and a large number of single vessels and small fleets amounting in all to probably nearly another 1,000,000 tons per year. These vessels, in addition to the twenty-four boats already owned by the Bessemer Steamship Co., give the Rockefellers a total carrying capacity for the season of 1900 of something over 5,500,000 tons of ore. This is in the neighborhood of 2,000,000 tons more than the total output of the Rockefeller mines, including the 1,400,000 tons to be carried for the Carnegie-Oliver people under their contract, and would seem to tie up enough of the "wild" tonnage of the Lakes to force Carnegie into giving the Rockefellers most of his surplus ore to carry and at rates which they might dictate, both on the surplus and on the 1,400,000 tons contracted for.

The Rockefellers while engineering this deal undoubtedly took into consideration the fact that the Lake ship yards were already fairly well filled with work, and the apparent impossibility of their being able to get the material for building any more vessels. They have, however, seemingly underestimated the strength of their opponent, and they were unquestionably surprised at the announcement a few days ago that the Carnegie interests had made a contract with the American Ship Building Co. for six of the very largest type of steamers for delivery early in 1900, they agreeing to furnish all of the material themselves in order to enable the shipyards to complete the vessels. The position of advantage seems to have changed, and the question now is "what will Rockefeller do with all his surplus tonnage if Carnegie succeeds in covering his surplus ore?" The situation is interesting, and the final outcome of this conflict will be watched with the closest attention by all interested in Lake marine matters.

In the meantime the advantages to the small individual owners and to the shipbuilders of the Lakes have been many, and the profits on this and the next season's operations will be such as were never expected to be realized again on the Great American Lakes, and will dim the stories of the palmy days of long ago.

There are now building and under contract at Lake yards twenty-five steel vessels, valued, approximately, at $7,500,000. Twenty-two of these are under contract with the American Ship Building Co., and are described as follows: Four 500 ft. steamers of about 8,000 tons carrying capacity each, for A. B. Wolvin and the American Steel & Wire Co. interests; two Welland Canal size steamers of about 3,000 tons capacity for Mr. Wolvin and others; six steamers of about 7,600 tons capacity each for the Carnegie-Oliver interests; one steamer and two tow barges of a total capacity of 21,000 tons for the Bessemer Steamship Co. (Rockefeller interests); one steamer for Mitchell & Co. of 6,000 tons; two tow barges for the Minnesota Steamship Co. of over 7,000 tons each; one Welland Canal steamer of 3,000 tons for R. R. Rhodes; two steamers of 6,000 tons each for Eddy Bros., and a sidewheel passenger boat for the Detroit & St. Clair River Excursion Co. The three vessels building at yards outside of the combination are: a package freighter of 5,000 tons for the Lehigh Valley Transportation Co., building at the Union Dry Dock Co. yard at Buffalo, and two Welland Canal size steamers of 3,000 tons each, one building at Craig's yard at Toledo for Arthur Hawgood, and the other at the Jenks Ship Building Co. plant at Port Huron on yard account.

The only yard on the Lakes now building wooden boats is that of Capt. James Davidson at West Bay City, Mich., where there is now one large wooden steamer on the stocks, and where at least two more large vessels will undoubtedly be built within the next few months.

What might be termed a contest for the ownership of steamships of more than 10,000 tons gross is now going on between Great Britain and Germany. The former now owns about a dozen of such vessels afloat and the latter nearly two dozen; but next year the conditions may be changed, as a considerable number of steamships of the largest size are now under construction for British owners.

It is reported that the transatlantic liner *City of Rome* has been secured by the British Government and will be put into service as a hospital ship during the Transvaal war.

BOILER ARRANGEMENTS OF RECENT BRITISH AND FOREIGN CRUISERS.*—I.

BY F. T. MARSHALL, MEMBER.

During the past few months the company with which the writer is connected have completed the machinery of several vessels of the cruiser class, which differed so noticeably in the type of boiler fitted that he thinks some comparison of the system used, and some description of the arrangements adopted, may prove of interest to the members of the Institution.

The vessels referred to are H.M.S. *Andromeda*, built at Pembroke Dockyard; H.R. Portuguese M.S. *Don Carlos I.*, built at Elswick; and H.I. Chinese M.SS. *Hai Tien* and *Hai Chi*, sister vessels, also built by the Armstrong Company. With this paper a comparative table will be found, giving particulars of the power, heating surface, grate area, space occupied, and weight of the boiler arrangements of these vessels.

Owing to the courtesy of Sir John Durston, the writer has been able to add similar information regarding H.M.S. *Hermes*. This vessel is one of the latest second-class cruisers in the British service, and in size more nearly resembles the *Don Carlos* and *Hai Tien* than the *Andromeda* does. Particulars are also added of H.M.SS. *Eolus* and *Pallas*, which are typical second and third-class cruisers with cylindrical boilers.

BOILER ARRANGEMENTS.

The boiler installation of the *Andromeda* consists of thirty Belleville boilers fitted with economizers. These boilers are arranged in four watertight compartments, there being a separate funnel to each group. The stokeholds are fitted with the necessary arrangements for closing in, fans being supplied to work them under pressure if necessary. Each boiler-room is also supplied with a furnace air-pumping engine to supply air in jets above the fire-grates, and also in the combustion chamber under the economizer.

The arrangement of the boilers of the *Hermes* consists of eighteen Belleville boilers with economizers. These are arranged in three watertight compartments, each group having its own funnel.

The boiler arrangement of the *Don Carlos I.* consists of twelve Yarrow-type boilers arranged in two watertight compartments with two funnels. It is of interest as being the largest installation of small-tube water-tube boilers which has yet been tried at sea, and it may here be mentioned that all the trials passed off without the slightest hitch and no difficulties were experienced. The forced-draft fittings are on the closed stokehold system, there being four fans to each boiler compartment. In addition to the air which passes through the automatic draft plates at the front of the grate, a further air supply is given to the sides and back of the grate, by means of automatic flaps fitted in a screen built closely round the boiler front and fitting to the floor, sides, and top of the stokeholds.

The boiler arrangement of the *Hai Tien* and *Hai Chi* consists of four double-ended and four single-ended cylindrical boilers. These are placed in three watertight compartments, two double-ended boilers in the forward and aft compartments, and four single-ended boilers in the midship compartment. There are two funnels, two double-ended and two single-ended boilers being led into each. The forced draft arrangements are on the closed stokehold system, with four fans to each compartment. It will be seen that the boilers of these vessels furnish examples of three of the principal types of warship boilers, viz.: (1) the large-tube water-tube type, represented by the Belleville boiler; (2) the small-tube water-tube type, represented by the Yarrow boiler; (3) the cylindrical fire-tube boiler.

DETAIL CONSTRUCTION.

As to the detail construction of the types under consideration, that of the Belleville boiler has already been fully described in various papers read before the Institution. The economizer type of this boiler is fitted on the *Andromeda*. The tubes, which are of solid-drawn steel galvanized externally, are 4 1-2 in. dia. in the generator elements, and 2 3-4 in. dia. in the economizer elements in the boilers of the *Andromeda*. In the *Hermes* the generator tubes are 4 in. dia., and the economizer tubes 2 3-4 in.

In the boilers of the *Don Carlos* some departures have been made from the usual Yarrow type. The method of manufacture is to completely rivet up the steam drum, the tube holes being previously all drilled through a cast-iron template. The wing pocket tube-plates are also drilled to template, and are then erected together with the steam drum on a triangular frame. The boiler is then tubed in the ordinary way, and the tubes expanded and bell-mouthed, after which the ends and bottom plates of the wing pockets are riveted in place. This completes the part of the boiler subjected to pressure. The tube ends are readily accessible in the finished boiler by means of ordinary manholes in the steam drum and water pockets. These manholes are flanged inward, and fitted with ordinary internal doors. The tubes are of solid-drawn steel, the two rows next the fire being 1 3-8 in. dia., .128 in. thick, and the rest 1 1-8 in. dia., .104 in. thick. It will be noticed that all the tubes are straight, except the two rows next the fire, which are slightly curved. The reason for the adoption of this curvature is that these front rows of tubes, which are subject to higher temperatures and more sudden changes of temperature than the rest of the tube surface, have in some cases, when initially straight, shown a tendency to spring against each other in varying directions. This obstructs the uniform flow of the gases, besides being mechanically objectionable. By slightly curving the outer rows as shown, any springing takes place in a known and definite direction, and does not, therefore, have the effect above indicated, whereas the curvature is so slight that it does not appreciably interfere with cleaning or inspection.

The boilers are fitted with straight external downcomer stay tubes, and, in addition to this, a certain number of tubes at each end of each pocket are baffled off from the fire to insure them working as permanent downcomers, and, as far as possible, maintaining a uniform direction of circulation in the boilers. The tubes are arranged in the tube-plates with several gaps on the fire side. The object of this is to throw a great number of tubes into actual contact with the fire, and thus somewhat relieve the outer rows, which are very severely worked. This arrangement also somewhat increased the combustion space. There are no stay

*Paper read before the Institution of Naval Architects, England.

tubes actually distributed throughout the tubeplate, these not being found necessary, besides being objectionable, owing to their greater thickness, and consequent different expansion to the adjacent tubes. That they are unnecessary is, the writer submits, shown by the following experiments made upon this point:

A tube 1 1-8 in. dia., .104 in. thick, standing 1-8 in. above tubeplate, and merely expanded in, resisted a load of 4.6 tons being drawn out. A similar tube, standing 1-16 in. above, required 4.22 tons, and a third just flush was drawn out by 3.3 tons load.

It will be seen that the strength of a large nest of these tubes is enormous, and is further increased by all the tubes being bell-mouthed inside. This latter operation also has the effect of improving the flow of water into the tubes, and thus assists circulation.

A matter of great importance in boilers of this type is the design of the casing work. These casings have to withstand not only high temperatures, but many sudden changes of temperature. They require to be stiff to maintain their form, but must be arranged to accommodate themselves readily to varying conditions of strain produced by heat, and, above all, they must remain airtight. The form of casing adopted has been found to give no trouble whatever. It is arranged in panels, any one of which can be readily removed for examination or overhaul of the part of the boiler at which it is situate. The form of flange attachment adopted gives great freedom for expansion and contraction, besides stiffening the structure.

As to the cylindrical boilers, these are of the usual form and proportions adopted for vessels of similar type. There is a separate combustion chamber to each furnace. The tubes, which are of lapwelded steel, are 2 1-2 in. dia., and all fitted with the Admiralty cap ferrule in the combustion chamber end.

FEED ARRANGEMENTS.

This is always an important matter, but specially so in water-tube boilers holding comparatively small quantities of water, and it becomes most desirable that the feeding should be automatic. The system adopted in the *Andromeda* is that generally used with Belleville boilers. Two large feed tanks, holding in all 13 tons of water, are placed high up in the engine room. These large tanks are necessary, owing to the variable weight of water in these boilers when working at the different rates of evaporation due to sudden changes of speed of ship. The feed water is taken from the hot-well by special pumps, and is pumped through the filters into the feed tanks. Thence it flows to the boiler feed pumps, and is delivered into the boilers through Belleville feed regulators, which control the speed of the pumps by means of pressure produced by the inlet valves, which are actuated by a float arrangement.

In the case of the *Don Carlos* the feed water is pumped by the air pumps into two vertical feed tanks, each holding 3 1-2 tons of water. Thence it flows by gravity through the feed filters to the feed pumps in the stokeholds, of which there is one to each boiler. The pumps are of duplex type, and are controlled by Mr. Yarrow's special arrangement, the steam supply to the pumps being taken from a guarded pipe just above the normal water level, so that, if the water is high in the boiler, it enters the pump cylinder, and so checks the speed of the pump. The fitting is extremely simple, and worked admirably throughout the trials, and also when steaming at low speeds in the river, etc. It has, however, the objection of being somewhat wasteful, and is barely so sensitive as the arrangements which check the feed supply direct.

The feed system used for the cylindrical boilers is for the air pumps to deliver to a vertical tank in the engine-room, holding 4 3-4 tons of water. From this it flows by gravity to the boiler feed pumps, which are in the stokeholds which deliver through the filters into the boilers, the feed regulation being by hand.

SPACE AND WEIGHT.

On looking at the floor area occupied by the three types of boiler, it will be seen the horse power developed per square foot under natural draft is approximately the same. In other words, that for continuous steaming practically the same power may be obtained from the same size of boiler-room whichever of the three systems is adopted. If, on the other hand, the maximum powers are considered, the advantage of both the Yarrow and cylindrical type is very marked, as by the use of forced draft very much higher powers may be developed for short periods. Again, looking at the heating surface contained in the various boilers per square foot of floor space, it will be seen that the Belleville and cylindrical type, which have about the same amount, have both substantially less than the Yarrow system. This seems to indicate that the loss of economy of the Yarrow type, when moderately forced, will not be very serious, whereas the cylindrical boilers can only be forced at a sacrifice in economy. This is borne out by experience, although at low powers the cylindrical type is more economical.

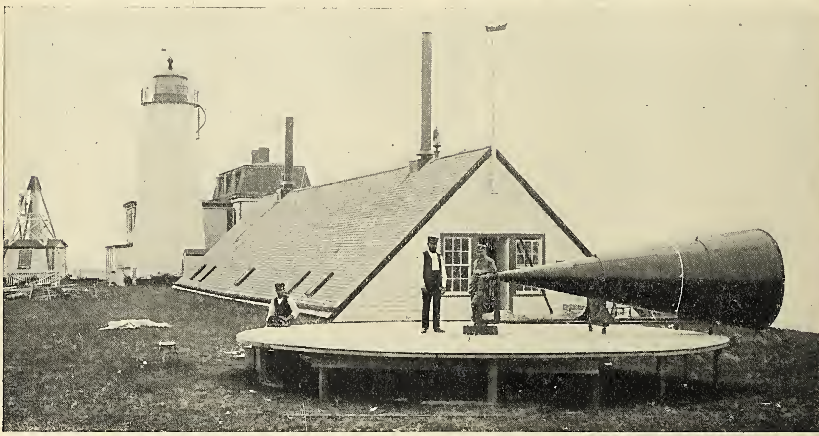
On comparing the grate area per square foot of floor space, the Belleville type possesses a substantial advantage. This is still more evident if comparison be made on the basis of 6 ft. 3 in. firebars, and there is an unquestionable loss of efficiency in stoking longer bars for long consecutive periods. The large grate area on moderate length of bar obtained on a given floor space is one of the strong points of the Belleville type, and makes it an excellent boiler for maintaining high sea speeds for considerable lengths of time. This great gain is partly discounted by the loss of efficiency, if the stoking is indifferent. Owing to the tubes being so close down to the grates, the fires have to be kept very thin but very uniform to insure good combustion. This trouble has been minimized by the introduction of a combustion chamber in the economizer variety of the Belleville type, but it is still a real one, and in evaporative trials a change of stokers may easily affect the evaporation per pound of coal to the extent of 10 per cent. This difficulty is noticeable also in the Yarrow type, but to a less degree, owing to there being much more space for combustion before the gases come in contact with the tube surface.

A recent issue of Lloyd's Register gives the British Empire a total, for last year, of 10,998 vessels of over 100 tons, these vessels having a total tonnage of 13,988,508 tons. The United States is put down as having 3,010 vessels of a total of 2,465,387 tons, which places this country second on the list.

IMPROVED APPARATUS.

Fog Signal Experiments.

How to render navigation safe in thick weather is a question which has engaged the attention of many inventors and experimentalists without any very satisfactory result at the present day. Fog signals there are in great variety, but there are two great uncertainties attending their use, whether whistles, Dabol trumpets or sirens are used. One is the difficulty in locating the source of sound with accuracy, and the other is the zones of silence with which a signal is sometimes surrounded. In sailing toward a fog signal different persons may vary ninety degrees in their estimate of its true direction, and when going away from the sound the difficulties are much increased. There are now in use several instruments, modifications of the megaphone, which are intended to be carried on vessels for the purpose of locating fog signals, be they on ship or shore. All such inventions are intended for the listener, and were there fifty vessels in the vicinity of one fog signal each would have to be provided with an instrument for locating the signal—not a likely condition when the possession of the instruments is optional. It occurred to R. F. Foster, the inventor of the instrument of which we here publish an illustration, that this was working at the wrong end of the problem, and that the proper place to locate a fog signal was in the signal itself, so that if a person heard it at all he could be certain of its direction, without being compelled to use any instrument. On this theory a signal was built and installed at Falkner's Island, in Long Island Sound, under the supervision of the United States Lighthouse Board. The apparatus consists in brief of an immense megaphone, mounted on a circular table. By changing the position of the 'phone toward each of the principal points of the compass in turn, and by blowing a different signal at each point, the compass bearing is given to passing vessels. Experience with the instrument goes to show that the sounds can be confined to an arc which is equal to the angle of the megaphone, and that unless a vessel is directly in the axis of the instrument it can not hear anything at a distance beyond two miles. Within the angle of the instrument a vessel can hear the signal which is sent in that direction even if it is eight or ten miles away. As the vessel approaches within two miles it can faintly hear signals when it is not in the angle of the megaphone, but the signals sent directly toward the vessel are always distinct. By getting its bearings in different points of its course, a vessel may determine, by triangulation, not only the position of the observed signal, but its distance. The apparatus works automatically, a three-horse power gas engine being sufficient to pump all the air required for blowing the signals and to turn the worm gear that revolves the megaphone. The piston of the signal valve works against a ring which controls the long and short blasts, something on the principle of a cam. In the apparatus as arranged for moving vessels this ring is so placed that it can be kept headed to the north, so that the signals are always sent in their proper direction, no matter how much the vessel may change her course. When the megaphone, in the course of its revolution, points directly over the bow of the vessel, a supplementary signal of a different character is blown. This shows the listener the exact angle of the course being steered from the observed position, the megaphone traveling from north to east at the rate of five seconds for each point of the compass. This invention is controlled by the Hamilton-Foster Fog Signal Company, 71 Broadway, N. Y., where a working model of the apparatus can be seen.

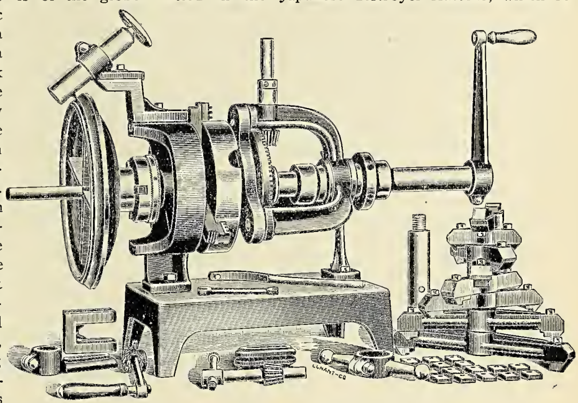


EXPERIMENTAL STATION OF HAMILTON—FOSTER FOG SIGNAL, FALKNER'S ISLAND, CONN.

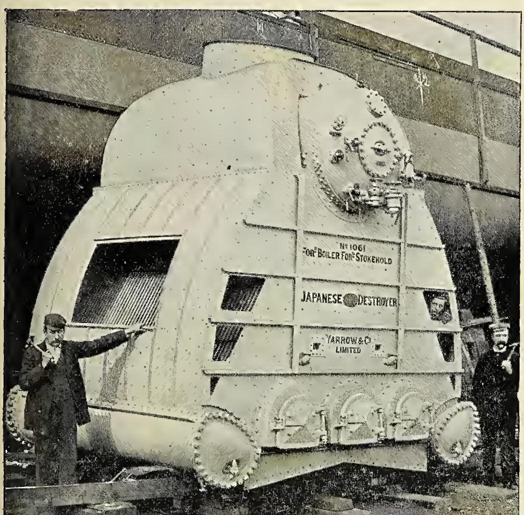
Valve Reseating Machines.

To reseat valves in position is the purpose of the Dexter patent valve reseating machine, which we here illustrate along with the disc cutter attachment. This size machine will work on any size globe valve from 4

in. to 12 in., inclusive, without removing the body of the valve from its connections, and with the disc cutter attachment the valve itself, when it is of the globe type, can be refaced. The disc mounted on a spindle is held in a small chuck, and to this is given a rotary motion by turning the crank on the spindle of the machine. The tool is held rigid and is gradually fed over the contract surface of the valve. Disc valves with flat faces can also be turned true by the use of another attachment which is provided. The advantages of the apparatus in respect to speed, accuracy and convenience, when compared with the use of the hand scraper and abrasive substance for grinding in need not be more than mentioned. The apparatus has been in use in the United States navy for a considerable time, among the ships so supplied being the battleships *Oregon*, *Iowa* and *Massachussetts*, and the armored cruisers *Brooklyn* and *New York*. A variety of other reseating machines on the same principle for all sizes of valves, and for special uses, are made by the manufacturers, the Leavitt Machine Co., Orange, Mass. Special care is taken with the cutters of these machines, which are also protected by patents. The cutters for the smaller valves are made of round steel and those for the larger sizes of flat bars. They operate with a shearing cut, producing a perfectly smooth surface.



DEXTER VALVE RESEATING MACHINE.



YARROW EXPRESS WATER TUBE BOILER.

Yarrow Express Boilers.

Our engraving shows one of the four Yarrow boilers fitted in the Japanese destroyer *Akebono*, which recently attained a speed of 31.15 knots on trial. This boat is one of six destroyers ordered from Yarrow by the Japanese Government, each vessel measuring: Length, 220 ft.; beam, 20 ft. 6 in., and having twin screw engines, with cylinders 20 1-2 in., 31 1-2 in. and two 34 in. dia. and 18 in. stroke. The boilers are built for a working pressure of 230 lbs. per sq. in., and are the largest of their type yet constructed. With water and fittings each weighs 18 tons. The capacity of each boiler is figured at 1,600 horse power. This type of boiler is fitted with straight tubes, which can be easily examined internally and cleaned out readily. On the trial of the destroyer, with 1 1-2 in. air pressure in the stokehold, a pressure of 226 lbs. was maintained on the boilers, the engines turning up to 439 1-2 revolutions. We are informed that there was no flame visible at the funnels and the paint on them "was very little darker on the return of the boat than when she started." These boilers were designed and built by Yarrow & Co., Ltd., Isle of Dogs, Poplar, London, E., England. This type of boilers has also been fitted in large war vessels.

The Hamburg-American Co. has made a new departure by ordering from a German yard a 400 ft. steam yacht which is to be fitted out for the carriage of first-class passengers only, and the necessary stores and coal, the intention being not to carry any cargo. The new vessel is to be named the *Princess Louise Victoria*, and in the season she will make trips to Norway, the Mediterranean and the Orient.

MARINE ENGINEERING

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We desire to call the attention of our subscribers to the changed address of this publication from the World Building to 309 Broadway, New York. It is naturally with reluctance that a publication removes from a location with which it has become more or less identified, but in the present instance the change was compelled by the rapid and continuous growth of the undertaking. Once before, since the commencement of publication, early in 1897, a removal was made necessary for the same reason. On that occasion enlarged quarters in the same building temporarily sufficed. Now however, the activities and business of this paper are such that we have been compelled to occupy a very largely increased amount of space. To those of our friends who have visited us at our former office, and to those whom we have not as yet had the privilege of greeting in person, we extend a cordial welcome to the new home of Marine Engineering.

ALDRICH & DONALDSON.

ANOTHER series of races for the *America's* Cup has been concluded, with the usual result—the cup stays on this side. Now that the races are over, and with America rests the victory, we feel at liberty to discuss certain features connected with the contest. As a cup defending and a cup "lifting"—to use the idiom of the challenger—match it was without question a remarkably well conducted affair. As an international competition between sport loving yachtsmen, pure and simple, its success, we believe, can be seriously questioned. It is well to recall the origin of these cup races. In August, 1851, the yacht *America* entered a race in British waters, around the Isle of Wight, and won easily by eighteen minutes. There was no press agency accompaniment to the entry of the American boat, whose owner in a thoroughly sportsmanlike fashion sailed in, won the race and the cup, and took it home. His boat was a cruiser built for yachting, not cup lifting, and was a good representative of the American type. Forty years later the cup is challenged for by a gentleman, who, according to his own statement, does not know how to sail a yacht; and the yachts themselves are such in name only. In reality they are huge racing machines, built at enormous expense, and necessitating the employment of large crews; and they are adapted only for the special purpose of sailing for the Cup or in other similar contests. On the part of the last challenger entire dependence was placed on the professional services of those in his employ to win the cup; and this, by contrast, actually caused severe criticism of the presence of amateurs on board the *Columbia.* Under the conditions there may have been some grounds for criticism, but it is certainly a peculiar state of affairs when the presence of the owner and his fellow clubmen on board one of the yachts calls for censure. As a matter of fact, the international cup races have become not at all so much a contest between amateur yachtsmen as a matter of engineering construction—the pitting of the skill of one designer here against that of a designer abroad. In the sailing of the boats there is little to choose from; wind and tide are identical for both, and the whole contest practically narrows down to one of design, and, of course, construction. In this may be properly included the propelling mechanism—sails. In the recent race the British boat (not Irish, as some would have us believe) had a marked advantage in this respect, and so the more plainly is shown the superiority of the American design of hull. In the matter of sails there is, indeed, a distinct retrogression on our side in the forty odd years. When the *America* sailed her winning race the features of all others that attracted attention and praise was the set of her sails. Even the conservative and authoritative London *Times*, after the race, referring to the *America*, admitted: "The way her sails were set evinced a superiority in the cutting which our makers would barely allow; but certain it is that while the jibs and mainsails of her antagonists were 'bellied out' her canvas was as

flat as a sheet of paper." Conducted with a view to promote yachting interests at large, instead of merely cup lifting or defending, the value of these contests would be immeasurably greater than now. Bringing down the maximum size of boat allowed to ordinary dimensions would be the first step toward this end. The immediate result would be, that the expense of an effort to lift or defend the cup would come within the means of many who are yachtsmen rather than capitalists. A variety of designs would be put forward, representing the skill of many designers, and in this way scientific effort would be aided by wide experience with various types. Yacht building and racing would be greatly stimulated. It would then be a possibility with many to win in the trying out process, and eventually in the race itself. Instead of a concentration of interest on one series of races, there would be a healthy competition among local sportsmen at various centers, and the event would be truly representative of the sport as conducted in the competing countries. No doubt a rearrangement of the governing conditions would be needed—a matter presenting no insuperable difficulties.

IN his masterly paper read before the British Association—the publication of which we begin in other pages in this issue—Sir William White, Constructor-in-Chief, of the British Navy, refers at some length to the value of model experiments, and after touching upon the work done at various government naval experimental stations, states very plainly his opinion of the future possibilities of such research in these words:

> In this direction, however, I am bound to say that much might be done if experimental establishments capable of dealing with questions of a general nature relating to resistance and propulsion were added to the equipment of some of our universities and colleges. Engineering laboratories have been multiplied, but there is as yet no example of a model experimental tank devoted to instruction and research.

In connection with these remarks it should not be forgotten that at Cornell University, an institution which has always held first rank in its technical equipment, a start has been made which we hope may soon result in the establishment of a plant for experimental research, such as Sir William White refers to—a plant suitable for research in all those branches of hydromechanics which are of such vital importance to the naval architect and marine engineer. It may be recalled that an extensive hydraulic laboratory has recently been installed at this institution, one feature of which is a canal or tank suitable for experiments in this field of investigation, whose importance has recently been recognized by the government in the installation of the magnificent equipment at the United States Navy Yard, Washington, D. C. While the canal at Cornell is but 340 ft. in length by 16 ft. wide and 10 ft. deep, and, therefore, smaller than the government tank at Washington, it is nevertheless of quite sufficient size for work of a most valuable character, and we may be sure that in due time, when the needed equipment shall have been provided, the Cornell tank may be confidently looked to for most valuable additions to our existing knowledge in these subjects. It is understood that at the present time funds are lacking for the immediate equipment of the canal with the necessary apparatus, and due to this fact alone the inauguration of important investigation is for the moment delayed. Here is an opportunity for those interested in marine construction to forward its interests in a most direct and valuable way. The opportunities here are so great that any further delay by reason of a lack of equipment is most seriously to be regretted, and we may be permitted to hope that in the immediate future ways will be found of providing the needed funds and of installing the necessary apparatus. The opportunities of an experimental establishment thus installed under educational auspices alone will be quite exceptional and unique. It will be unhampered by commercial restrictions, or by rivalries, either commercial or naval. The information obtained, instead of being deposited in a safety vault as has hitherto been the case, at least in all the European establishments, will be given freely for the benefit of all who may be interested. In these days of sharp commercial rivalry it is safe to say that other things equal, the shipyard which combines a thoroughly up-to-date equipment and a practical ship and engine building staff, with a scientific staff capable of taking every advantage of the facts which experience and special investigation may furnish, will take the lead. The significance of an experimental establishment thus free to investigate any and all subjects of scientific interest, and equally free to give forth the results for the benefit of those who may choose to profit by them, is clearly seen from this point of view. The opportunities of Cornell University in this field are, therefore, at present quite unique, and of an importance hard to overestimate. Let us hope that she will be able to realize the expectations which we may justly form.

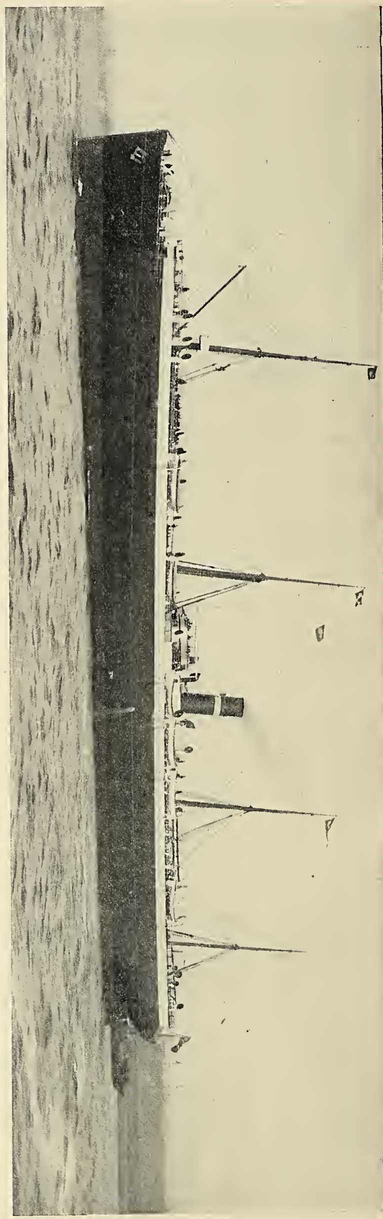
MARINE BREAKDOWNS AND LOSSES.

LOSSES OF THE BRITISH STEAMSHIPS SCOTSMAN AND BAY STATE.

Many serious marine losses, both home and foreign, occurred during the past few weeks. Late in September the new Dominion liner *Scotsman*, bound west from Liverpool to Montreal, went ashore in the Straits of Belle Isle, and will probably be a total loss. She had a large passenger list and valuable cargo. Several lives were lost, due chiefly to the ruffianism of the crew, which is reported to have been composed of the scum of the Liverpool docks, shipped to replace the regular seamen who were on strike when the vessel sailed. The weather was bitterly cold when the mishap occurred, and those of the passengers who got ashore safely had to spend several days and nights on the bare rocks, scantily clothed and with little or no food to eat. The only habitation near was the Belle Isle light, five miles distant in a direct line, but much further by the only road, which led through almost impassable country. Signals for help were made from the lighthouse at intervals, but not until the fifth day after the mishap did assistance arrive in the shape of the Elder Dempster steamship *Montfort*, which was passing. Many of the passengers were transferred to this vessel, and subsequently aid reached those who were left behind. According to the statement of cabin passengers who finally reached New York the crew broke loose after the vessel struck and laid violent hands on passengers who had valuables, also breaking into the cabins and liquor stores of the vessel. Many of the crew who got away were arrested at Canadian and British ports. Captain Skrimshire of the *Scotsman* is reported to have laid the blame for the mishap on the Canadian authorities, who recently removed an explosive fog signal at Belle Isle and substituted for it a siren, notice of which had been published.

The *Scotsman* was only about four years old, and was a good product of the Harland & Wolff works of Belfast, Ireland. Her dimensions are as follows: Length, 470 ft., beam, 49 ft., and depth, 31 ft. Her gross tonnage is 6,041 tons. Her engines are triple expansion, driving twin screws, and she is fitted with four pole masts.

The Warren liner *Bay State*, from Liverpool to Boston, went ashore in a dense fog in Chance Cove, about sixteen miles from Cape Race, on October 3, and became a total loss. Her crew took to the boats and were picked up at sea.



Photograph by Priestley Sons, Ltd., Liverpool, England.

DOMINION LINER SCOTSMAN IN SERVICE BETWEEN MONTREAL AND LIVERPOOL—LOST IN THE STRAITS OF BELLE ISLE RECENTLY—6,041 TONS GROSS.

Rear-Admiral George W. Melville, Engineer-in-Chief, U.S.N., has been elected an honorary member of the Franklin Institute of Philadelphia, Pa.

Japan is gradually increasing her shipbuilding facilities. There is now under construction at Nagasaki a steamship of 6,000 tons.

John Donaldson, a member of the firm of famous torpedo boat builders, Thornycroft, at Chiswick, London, died recently, aged 58 years. Mr. Donaldson was widely known as an engineer and as an advocate of the torpedo boat.

EDUCATIONAL DEPARTMENT.

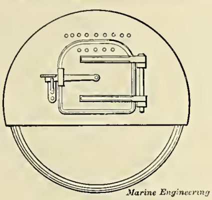
HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS—II.

BY DR. WILLIAM FREDERICK DURAND.

§ 2 MATERIALS AND CONSTRUCTION.

[3] CONSTRUCTION OF FIRE TUBE BOILERS—*Continued.*

Furnace Fronts and Doors.—The furnace front is a fitting attached to the mouth of the furnace, and carrying the furnace door. In Fig. 1 a common form of arrangement is shown. The front consists of a cast iron shell forming the outer part, and made with lugs or a flange for attachment to the furnace. The opening for the door is formed, as shown, within this front or door frame as it is sometimes called. Attached to this frame and with a space between is a plate of cast or wrought iron forming the inner wall. This is pierced with a large number of small holes, while the frame is provided with a smaller number of larger holes. These are provided for the purpose of admitting air to the furnace above the grate. The inner plate is subject to the direct action of the fire, and although cooled somewhat by the air passing through, it is liable to burn out from

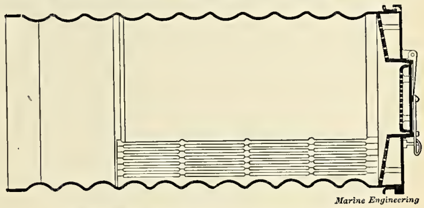


FURNACE FRONT.—FIG. 1.

time to time. It is for this reason that it is made as a separate piece, and so is readily replaced as occasion requires. The door is formed in much the same way as the frame, and is provided with holes in a similar fashion and for the same purpose. Often a small covered peep-hole is provided for examining the fire without opening the door. In some cases also a small opening is made through which a slice bar may be introduced for stirring or breaking up the fire without opening the door. A form of slide or gridiron is also sometimes fitted so as to control the amount of air entering above the grates. In some cases the doors and frames are made of flanged steel plate instead of cast iron, while much variety exists in the arrangement of the holes for the introduction of the air. Certain special fittings necessary to adapt the furnace fronts and doors to the application of forced draft will be described at a later point.

The ash-pit door usually consists simply of a plate of thin sheet steel provided with the necessary lugs and handles, and covering the front opening in the furnace below the grate bars. It is used chiefly as a damper in connection with closed stokehold forced draft.

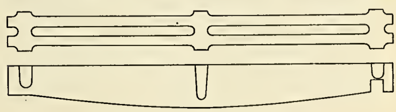
Grate and Bridge Walls.—The general arrangement of the inside of the furnace is illustrated in Fig. 2, which shows a horizontal section through a furnace. The grate extends from the front of the furnace to the bridge wall. See Fig. 4. The bottom of the door frame extends back a little way and drops down, forming a kind of shelf for the support of the front ends of the grate bars. In some cases this extension of the door frame extends back some distance, forming the so-called *dead plate*, upon which bituminous coal may be piled when first



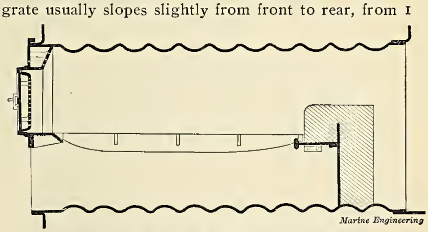
HORIZONTAL SECTION OF FURNACE.—FIG. 2.

fired, so as to provide for the gradual distillation and combustion of its gases.

The grate bars may be made in a large variety of forms. In Fig. 3 is shown the standard type of cast iron bar. There are two lengths of bar in the length of the furnace, supported by the door frame in front and bridge wall at the rear, and by *bearing bars* in the middle. These latter in turn are supported at their ends by attachment to the furnace. The bars are usually cast double, as shown, while for convenience in fitting grates of varying widths, a small number of single bars are usually provided. The width of air space between the bars is usually made about equal to the width of the bar, or about one-half of the entire grate area. One end of the bar is made sloping as in the figure, in order to provide for expansion. The surface of the grate usually slopes slightly from front to rear, from 1 in 24 to 1 in 12, covering the usual range of angle. It is doubtful if there is any necessity for this slope, which was probably introduced as a provision against the sliding of the fire to the front in heavy weather. Cast iron grate bars often have a shallow groove running along the top. This fills with ashes and tends to prevent the clinkers adhering to the grate.



CAST IRON GRATE BARS.—FIG. 3.



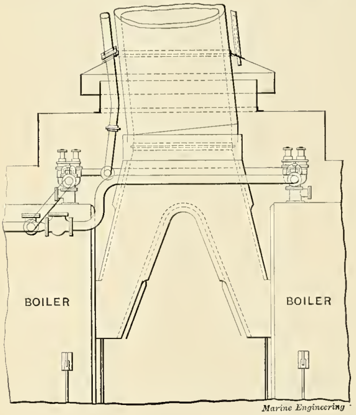
VERTICAL SECTION OF FURNACE.—FIG. 4.

In addition to the type of bar shown in Fig. 3, square wrought iron bars running the whole length of the furnace are sometimes used, and there is a large variety of patent and special kinds of shaking grate. The purpose in grates of this character is to provide means for breaking up and working the fire without the need of opening the door. Many of them accomplish this end to a considerable extent, but the greater simplicity and cheapness of the plain cast iron grate, as in Fig. 3, insures for the latter a wide use, and it is still the favorite in ordinary practice.

Turning now to the bridge wall, a common arrangement is shown in Fig. 4. A casting extends across the back of the furnace and is supported by attachment at the sides. This supports the back ends of the grate bars, as already referred to, and also a wall of fire brick which forms the back limit of the grate, and over which the products of combustion pass on their way to the combustion chamber.

Instead of fire-brick, the use of cast iron for bridges is becoming frequent in modern advanced practice. Such bridges are of ribbed or channeled form, and in use they become sufficiently covered with ashes to form a protection against the heat of the fire.

Front Connections and Funnel.—After leaving the tubes at the front end the gases and smoke must be guided to the base of the funnel. This is done by the front connections or smoke boxes and uptakes, as shown in the sketches. Fig. 5 shows the connection made between two single ended boilers and one funnel, used in common by both. The boilers are placed front to front in an athwartship fire room. Fig. 6 shows the connections between one double ended boiler and the smoke pipe. These connections are formed of sheet metal riveted up in two or more thicknesses with an air space or non-conducting material between. The term *front connection* refers more especially to that part of the passage directly in front of the tubes. This is provided with doors swinging upward to allow examination, cleaning and repair of the tubes. A swinging damper is often placed in the uptakes for controlling the draft as may be desired, especially where two or more boilers are connected to one stack. The funnel or stack is also made of sheet metal riveted up, and in good practice in two thicknesses with a considerable air space between. This tends to prevent loss of heat by radiation, and thus the temperature of the gases is kept as high as possible while in the funnel, as is necessary for good draft. It may be remembered that for boiler economy the temperature of the waste gases at the front connection should be as low as possible, while for the sake of the draft all further loss of heat while in the funnel should be prevented. Around the base of the funnel is fitted an additional air screen or passage, known as the *air casing.* See Fig. 7. This serves to ventilate the fire-rooms and to protect the neighboring parts of the ship from the heat radiated by the funnel. The air casing is protected from the weather by a sloping ring of metal attached to the funnel, as shown in Fig. 7, and known as the *umbrella.*



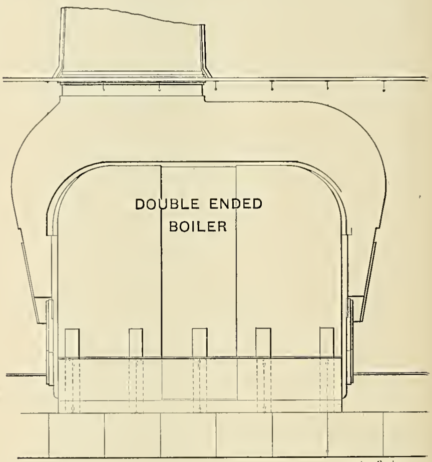


FIG. 5. FRONT CONNECTIONS, UPTAKES AND FUNNELS. FIG. 6.

The weight of the funnel is usually carried by straps or lugs attached to the structure of the ship, and it is furthermore stayed by guys on deck in order to provide the necessary steadiness and support in a sea-way. In small craft, however, the weight of the funnel is often taken simply by the uptakes and boilers.

The funnel is often provided with a cover which may be placed over the top when the ship is laid up, or when for other reason the funnel is not in use. The cover is usually kept a little distance above the top so as to allow the escape of smoke from small fires used for warming and airing the boilers. A ladderway should also be provided on the funnel to assist in examination, adjustment of guys, fitting of cover, etc. In small craft a damper is often fitted in the funnel near the base, to assist in controlling the draft.

CONSTRUCTION OF WATER-TUBE BOILERS.

Only a few points will require special notice under this heading. We have already seen that many types of water-tube boiler consist of one or more cylindrical drums above and one or more below, joined by a series of tubes. See MARINE ENGINEERING for July, Figs. 5-9. These drums, which are rarely more than 18 to 24 in. dia., are made from steel plates usually by flanging and riveting in the usual manner. The heads alone of such drums require consideration as regards bracing. If of sufficient size to require it they may be braced by through bolts as with boiler heads. In most cases, however, the heads are bumped or made of dished form, either concave or convex on the outside. The latter is preferable, as the pressure is then carried on the concave side, and according to the United States law such heads are allowed without bracing a pressure the same

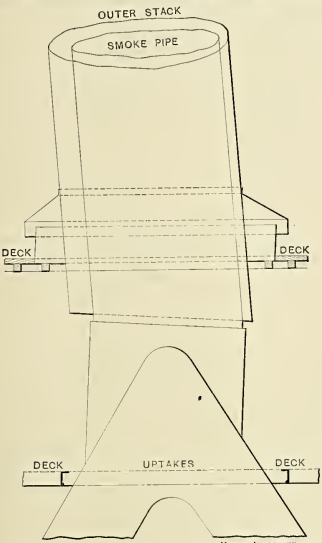


FIG. 7.

as that for a cylindrical shell of a diameter equal to the radius of the sphere of which the head forms a part.

It is much preferable to form the heads in this way, avoiding the need of bracing, and thus leaving the interior of the drum free for examination, at least so far as bracing is concerned. To allow access to the interior, manholes or hand-holes with appropriate cover plates are fitted to the heads. Instead of forming these drums with riveted joints, drums with welded joints have recently come somewhat into use, especially in naval practice.

With boilers having headers formed by the space between two parallel sheets, the necessary arrangements are quite different. These sheets require special support, and this is usually provided by screw stay-bolts or other equivalent stays worked between the two sheets attached to the tube sheet between the tubes as convenient, and securely tying the two sheets together. In some cases the outer sheets are supported by rod stays passing from head to head through the tubes. In such case the tube sheets are left to be supported by the tubes which are thus thrown into compression, and the tubes must therefore be carefully expanded, especially on the inner side of the sheet, in order to give sufficient hold to support the sheets in this direction.

The tubes of water-tube boilers are of wrought iron or steel, and welded or solid drawn. For the bent-tube boilers solid drawn steel tubes are to be preferred. For straight tube boilers welded iron tubes are still in common use. The tubes are secured to the tube sheets either by expanding or by special fittings with screwed joints. In general there is a force tending to draw the tubes out of the tube sheet or junction box or other form of header, equal for each tube to its cross-sectional area multiplied by the steam pressure. This force must be resisted by the tube fastening, and while it is not usually serious in amount, its existence should not be forgotten, and the need of care in the fastening is shown.

The furnaces of water-tube boilers are formed of grate-bars with a space below for ash-pit, all inclosed in the same general casing which surrounds the boiler as a whole, and as shown in the various figures referred to in the foregoing.

Often a considerable amount of fire-brick is used as a lining to the furnace, and for protection to the lower ends of the tubes.

Due to the great variety of forms of water-tube boilers, the details of construction often present the widest variation, and they cannot be so readily reduced to standard forms as in boilers of the fire-tube type.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XX.

BY WM. BAXTER, JR.

METHODS OF DISTRIBUTION.

There are two methods of electrical distribution, one of which is called the "series," and the other the "parallel." The first is also called the constant current system, and the second the constant potential system. Fig. 115 illustrates the series, or constant current system, and Fig. 116 the constant potential system. In Fig. 115 *G* represents the generator, and *L* the circuit,

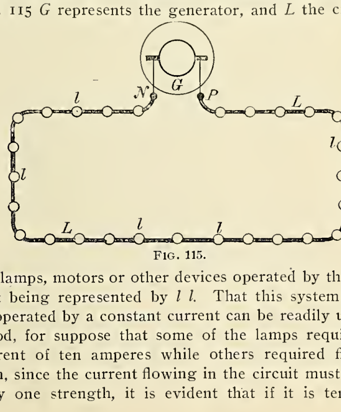


FIG. 115.

the lamps, motors or other devices operated by the current being represented by *l l*. That this system must be operated by a constant current can be readily understood, for suppose that some of the lamps required a current of ten amperes while others required fifteen, then, since the current flowing in the circuit must be of only one strength, it is evident that if it is ten am-

peres, it will suit the lamps that are designed to operate with that current, but it will not be strong enough for the others. Thus we see that if the devices operated in a series circuit are not all proportioned so as to re-

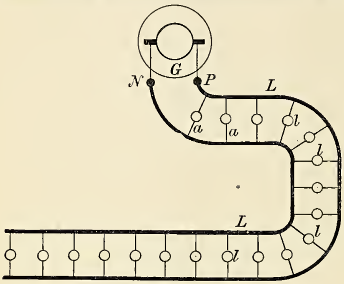


FIG. 116.

quire the same current strength, they will not work properly. The series system is not used on board ship, and in fact its only practical application on an extensive scale is for "arc" lighting. The electromotive force required for series systems is very high compared with the constant potential system, for the voltage must be sufficient to equal that of all the lamps added together; thus if there are fifty lamps, and each one requires fifty volts, the total E. M. F. of the current will be 2,500 volts, plus that necessary to overcome the resistance of the circuit wires. Making an allowance of 10 per cent for this we would have 2,750 volts as the total voltage that the generator would have to develop at the terminals *N* and *P*.

In the constant potential diagram, Fig. 116, *G* is the generator and *LL* are the main distributing lines. These start from the generator terminals *P* and *N*. The circles *l l l* represent incandescent lamps, which, as can be plainly seen, are connected by wires that run across from one of the mains to the other. With this system satisfactory results cannot be obtained unless all the lamps are designed to operate with the same voltage; for, as can be readily understood, the generator can only develop one pressure at the terminals *N P*, that is at any given instant, hence, apparatus that is constructed to work with this pressure will operate properly, but if there are other devices that are designed for some other pressure, they will not give satisfactory results. Suppose there are lamps connected between the mains *LL*, some of which are intended for a 50 volt circuit, and others for 100 volt, then if the actual pressure between the terminals *N* and *P* is 50, the first named lamps will give the proper light, but the others will not. When a beginner first looks at a diagram such as Fig. 116, he concludes that the first lamp *l*, being so much nearer to the generator than the last one, should take nearly all the current and leave the other lamps unprovided for. This, however, is not the result in practice, although it would be, if the relation between the resistance of the several parts of the circuit were as the beginner assumes it to be; in other words, the beginners' reasoning is correct, but he does not understand the conditions correctly. If every inch of length of the mains *LL* and the wires connecting with the lamps *l* and of the lamps themselves offered the same amount of resistance to the passage of the current, then more than half of the total current would pass through the first lamp, if the lengths of the wires were as drawn, and the remainder would nearly all go through the second one, leaving but a trifle for the third, and the next to nothing for the fourth. The resistance offered to the passage of the current by the main lines *LL*, the smaller wires connecting with the lamps, and the latter is very far from being the same; in fact the resistance of the lamps is almost infinitely greater than that of the wire, inch for inch, so that, although there may be several hundred feet of wire, its total resistance is not over 4 or 5 per cent of that of the

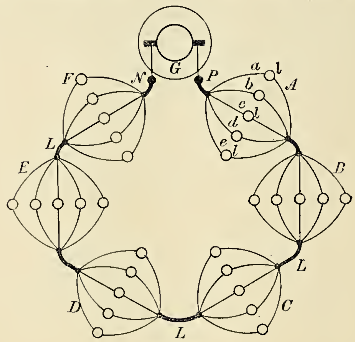


FIG. 117.

lamps. If we assume that the mains *LL* and the wires connecting these with the lamps offer no resistance whatever to the passage of the current, then we can see that the lamp the furthest from the generator will receive just as much current as the one nearest to it, for if the current can flow to either one without any hindrance whatever, it will flow to both in equal amounts. Now in practice it is not possible to obtain a conductor without resistance, although a large copper wire comes very near to it, so near that it requires accurate instruments to measure the resistance of a short piece. By making the mains *LL* of large wire and constructing the lamps so as to have a very high resistance, we approach very nearly to the conditions just explained, that is, of having a circuit without resistance. As will be shown later we can easily calculate the size the wires should be so that the current that will pass through the last lamp will be sufficient to give the proper illumination. It must be remembered, however, that the first conclusion of the beginner is correct, and that the first lamp takes more current than any of those that follow it, but the difference is very slight, in fact the last lamp will be traversed by a current not more than 5 per cent less than that passing through the first one, and the reason why the difference is so small is that the resistance of the wires is practically nothing in comparison with that of the lamps.

The series and the parallel are the two principal systems of distribution, but there are modifications of both that sometimes are convenient; one is shown in Fig.

117, and the other in Fig. 118. The first is called the series parallel, and the second the parallel series. The first can be used in connection with a constant current system, where the strength of the current is more than the apparatus requires; thus if the current is ten amperes, and we have lamps designed for only two amperes, we can arrange them as in Fig. 117 with five in parallel in each group. The arrangement of Fig. 118 is used where the voltage is greater than the lamps require, and is applicable to a constant potential system. Suppose we have a generator that develops a pressure of 250 volts, and that the lamps we desire to use are designed for 50 volts, then by stringing them five in series, as in the figure, we will be able to operate them successfully for 5 times 50 is 250. This last system finds application on board ship in cases where the voltage of the generators is about 100, and there are 50 volt lamps on hand, but none of 100 volts. It is not advisable to follow this construction for permanent work, and no one would do it if possessed of good judgment. For temporary jobs, however, it is often convenient, specially when the electrician is compelled to get along with what is available, and this is a common occurrence when the ship is away from port.

Fig. 116 shows the parallel system of distribution in its simple form. In practice such simplicity is seldom

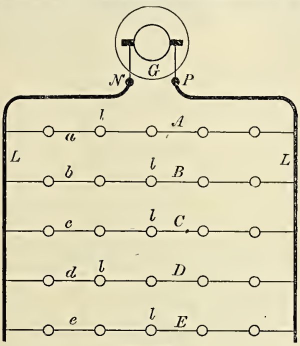


FIG. 118.

obtainable, or desirable. As a rule it is necessary to run out numerous branch circuits, and this is done in the manner shown in Fig. 119, in which the main lines running from the generator terminals are marked *LL*. In actual practice, these lines would run from the switchboard, but we have here shown them running from the generator so as to indicate more clearly the relation between the distributing circuits and the generator. From the main line branches can be run in either direction as shown at top and bottom of the figure, or only to one side as in the intermediate branches. Where the branch circuits are taken off, it is customary to provide distributing boxes, or panels as they are called, and these are provided with switches by means of which the current may be turned on or off as desired, so that all the lights supplied by any branch circuit may be controlled from a single point when necessary. When the lamps are in accessible positions, they are provided with a suitable switch so that each one may be turned off or on independently of the others.

If the boat is made of iron the skin can be used as the return circuit, just as the ground is used in some instances where small buildings are provided with a lighting plant. The practice, however, is not a good one and has nothing to recommend it but economy, and in any first class installation, the circuit wires should be independent of the ship and thoroughly insulated, particularly where there is any danger of making contact with the iron work. River boats, and even those engaged in near-by coasting service, are generally equipped with the same type of lamps and fittings as are used on shore, but sea going vessels should be provided with marine fittings, which are made with a view to withstand the effect of water and moisture. Incandescent lamps having the mountings secured by plaster of paris are not suited to marine work unless the plaster is covered with varnish, or is otherwise treated so as to make it moisture proof. Switches, fuses, junction boxes, etc., should be of the water tight type. Lamps situated in exposed places should be protected against injury, and this is also true of portable lamps. Lamps are constructed in a variety of designs specially for marine work, a number of which are shown in Figs. 120 to 133, which we are able to present through the courtesy of the General Electric Co.

Fig. 120 is the typical marine incandescent lamp, and is constructed so as to withstand the effects of moisture. Fig. 121 shows the way in which lamps that are designed to project downward from the ceiling are protected. Fig. 122 is a similarly protected side light adapted to narrow passages, or in freight compartments, where liable to be broken if not shielded. Fig. 123 shows a type of lamp provided with a steam tight protecting globe suited to boiler and engine rooms, etc.

Figs. 124 and 125 show designs of portable lamps. These lamps are not portable in the fullest sense, for

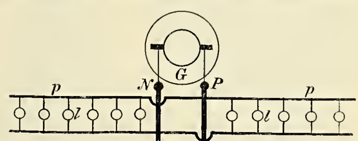


FIG. 119.

they can only be moved around as much as the length of the cable that carries the current will permit. They are generally used to inspect freight, or portions of the vessel not otherwise lighted. The end of the cable is

provided with a plug, that fits into a receptacle shown in Fig. 126. These receptacles can be located at as many points as desired, and by inserting the plug end

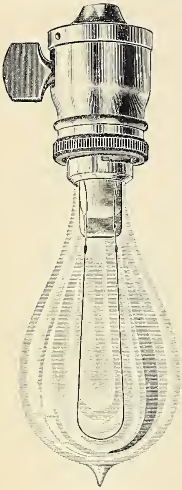


FIG. 120.

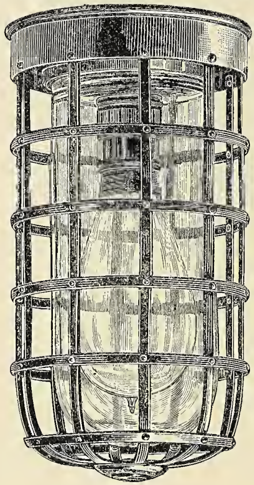


FIG. 121.

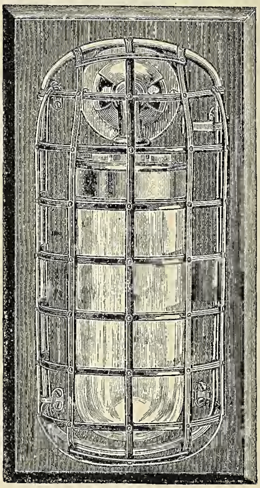


FIG. 122.

of the cable into the hole and turning the switch handle, a light is obtained. For engine repairs or examination of working parts portable lamps are a great convenience.

Fig. 127 is an ornamental ceiling fixture in which the

FIG. 123.

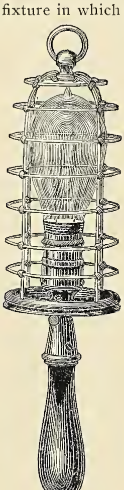


FIG. 124.

lamp is entirely inclosed. Fig. 128 is another design of ceiling fixture, and Fig. 129 is a side bracket lamp. As will be noticed, a characteristic feature of Figs. 127 to 129 is that they are substantially constructed, much more so than would be necessary for land work.

In Figs. 130 to 133 a lantern signaling system is shown together with the lantern, the signaling switch box and the cable with its coupling. The lanterns are colored, and each one is provided with two lenses, one white and one red. There are five lanterns, and all of them are connected with the switch box Fig. 132. By the movement of the handle of this switch, the light of any lantern may be made red or white. Sixty-two different combinations of the lights can be made. Fig. 130 shows the lanterns in position in the rigging. Fig. 131 shows one of the lanterns and a portion of the cable, and Figs. 132, 133 illustrate the manner in which

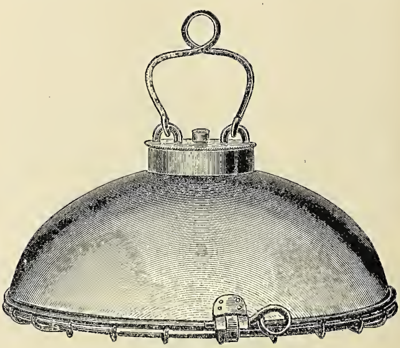


FIG. 125.

the connections between the terminals of the wires in the different sections of cable are made by the couplings.

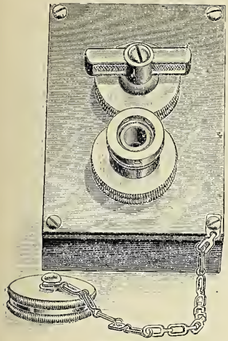


FIG. 126.

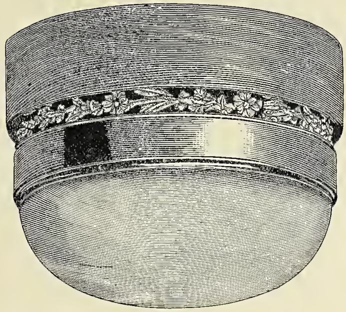


FIG. 127.

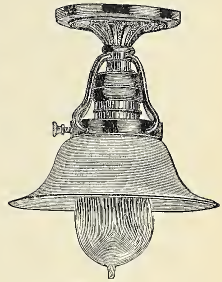


FIG. 128.

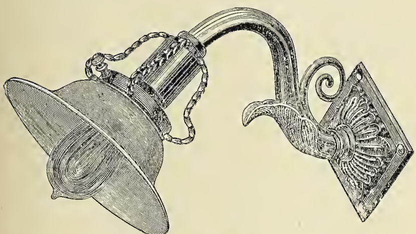


FIG. 129.

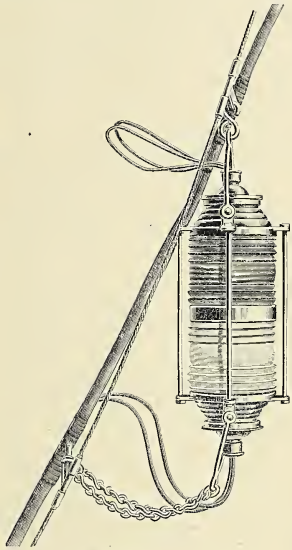


FIG. 131.

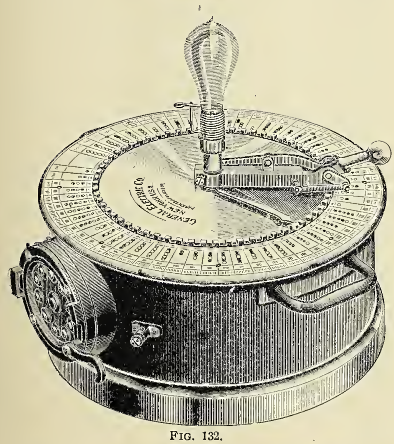


FIG. 132.

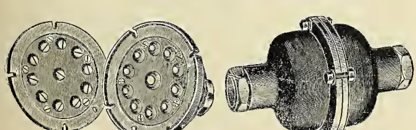


FIG. 133.

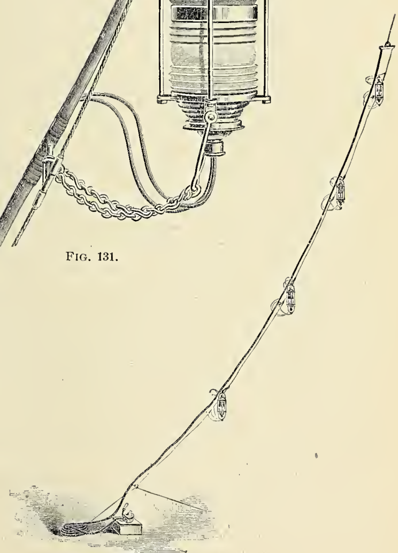


FIG. 130.

ENGINEERS' DICTIONARY.—XXI.

Guide or **Cross-Head-Guide**—A surface either formed on the columns or on a plate of metal carried by them, and serving to support the cross-head in its motion back and forth, and to take the transverse thrust to which it is subject. See under cross-head and column, Figs. 39 and 31.

Gusset-Plate or **Stay**—A form of boiler stay sometimes used for connecting together two plates at right angles to each other, as for example a boiler head to the shell. It consists of a plate of metal joined by angle irons and rivets to the two plates to be connected. See Fig. 9.

Hand-hole—A small oval shaped hole in a boiler shell for purposes of examination and cleaning. It is closed from the inside by a plate or cover with a flanged or lipped edge forming with sheet packing a joint on the inner edge of the metal about the hole.

Hand-Pump, Hand Reversing Gear, etc—The word *hand* as a prefix to the names of various mechanisms or appliances is commonly used to denote such forms as are or may be operated by hand, or without the direct use of power.

Hauled Fires—See under *Fires.*

Heater—See under *Feed Heater.*

Heating Surface—That part of the boiler through which the heat passes from the hot gas to the water. Any part of the boiler which is exposed to hot gas on one side and is in contact with water on the other may be considered as heating surface. It consists chiefly of the surface of the tubes, combustion-chambers and furnaces. See also under *Boiler.*

High-Pressure Boiler—A boiler specially intended for high pressures. During the period of change from the early types of marine boiler of more or less rectangular section and suited only for very low pressures to those of more modern form and suited for higher pressures, this term was often used in referring to any boiler of cylindrical form.

High-Pressure Cylinder—In a compound, triple or quadruple expansion engine the smallest cylinder, or that into which the steam enters first. See under *Engine.*

High-Pressure Engine—The high pressure cylinder, with its columns and the moving parts, sometimes referred to as the *high-pressure-engine.* The term is also sometimes used in referring to a *non-condensing* engine. See under *Engine.*

Holding-Down Bolts—The bolts which secure the engine bed-plate to the engine seating or foundation. See under *Engine.*

Horizontal Cylinder or Engine—A cylinder whose axis is horizontal, or an engine in which the moving parts move in a horizontal rather than in a vertical or oblique line. See under *Engine.*

Horse-Power—*Power* is the capacity to do work, and it is measured by the amount of work done in a given time. The unit of measurement used by engineers is the *horse-power* which is defined as 33,000 foot-pounds of work per minute, or 550 foot-pounds of work per second. To find the horse-power in any given problem, we must therefore find the number of foot pounds of work done per minute, and divide this by 33,000. To find the foot-pounds of work we must remember that work is measured by the product of a force by the distance through which it acts, and the common unit is the force of one pound acting through the distance of one foot, and is called a *foot-pound.* Hence to find the total number of foot-pounds we must measure the total force in pounds and the distance in feet, and multiply the two together. In the case of a common steam engine the total force is the total mean load on the piston, and the distance will be twice the length of stroke multiplied by the number of revolutions per minute. If p denotes the mean effective pressure per square inch, as found from an indicator card, and A is the area of the piston in square inches, then the product $p \times A$ is the total mean load. Also if L denotes the length of stroke in feet and N the number of revolutions per minute, then $2 \times L \times N$ is the distance in feet per minute, and the product of all these factors, or $2 \times L \times N \times p \times A$, will be the total number of foot-pounds of work per minute. This divided by 33,000 will then give the horse-power. As usually written this gives the common formula:

$$\text{Horse-power} = \frac{2\,pLAN}{33,000}$$

Horse-Shoe—In one of the forms of thrust bearing the rings or collars on which the thrust is taken are somewhat like a horse-shoe in form. They are provided with ears or projections at the sides, by means of which they are carried on heavy bolts at the sides of the bearing casing. Their adjustment on these bolts is controlled by nuts, and thus each horse-shoe may be so adjusted as to take its share of the thrust, or if any of them should become unduly heated, they may be slightly backed off and thus relieved of their load, and the danger of damage avoided.

Hot-Well—The chamber or space into which the air-pump delivers the water drawn from the condenser, and from which the feed-pumps take their supply for the boilers.

Hub—The central part of a screw-propeller to which the blades are attached, and which serves thus to unite them and to connect them with the shaft from which they receive their motion of rotation. The same term is used generally in referring to the metal about the shaft-hole of any rotating piece which turns upon or is carried by a shaft.

Hydraulic—The term *hydraulic* is used in referring to various forms of mechanism or appliance in which the moving force is derived from liquid under pressure. Strictly speaking, the term should only be applied when water is the liquid used, but by common usage it is employed no matter what the liquid, which may be either water, oil, or, very commonly, a mixture of water and glycerine.

Hydropmeter—An appliance placed in the bottom of a fire-tube boiler and used to promote a circulation of water, especially when getting up steam from cold water. It consists of a series of nozzles, one within the other, and its mode of operation is similar to that of a *bilge siphon* (see Fig. 5), the steam required being led from another boiler under the necessary head of steam.

NEW PUBLICATIONS.

Know Your Own Ship. By Thomas Walton. Fourth edition greatly enlarged; 1899. Chas. Griffin & Co., London; J. B. Lippincott Co., Philadelphia. Size, 5 3-4 by 8. Pages, 336. With numerous drawings. Cloth. $2.50.

This book, which forms one of *Griffin's Nautical Series*, is written primarily for shipowners, ship's officers and sailor folk in general, rather than for the naval architect or shipbuilder. To all interested as the above classes are, it is intended to give elementary and simple, yet accurate, ideas of the construction of ships and their principal nautical qualities, including stability, strength, oscillations, tonnage, freeboard, etc. The book is divided into eight chapters, as follows:

Chapter I explains in simple language and by the aid of suitable diagrams what displacement is, its equality with the weight of the ship, and its dependence on the form and dimensions of the ship as shown by the block coefficient.

In Chapter II an elementary explanation is given of the principle of moments, and of its application to the problem of shifted weights.

In Chapter III the equality of the buoyancy and weight is shown, and the loss of buoyancy due to bilged compartments is discussed, as well as the change in the distribution of the buoyancy when the ship either inclines or changes trim.

Chapter IV deals with the causes of stress on the structure of the ship, and especially as to its dependence on variations in the loading and in the distribution of the water ballast.

Chapter V takes up in some detail the construction of the ship and discusses the leading features with an explanation of Lloyd's numerals and their use in determining the various scantlings. Special features, such as engine foundations, shaft-struts, etc., are also given some attention.

Chapter VI is divided into a number of sections, dealing with stability in general, rolling, ballasting, loss of stability due to bilged compartments, relation of stability to sail area, etc.

Chapter VII deals with the subject of tonnage, and shows its importance to the shipowner from the economical point of view. The cases commonly arising are discussed, and the various deductions, etc., are explained in detail.

Chapter VIII deals similarly with the subject of freeboard, and the book closes with a collection of test questions, and an appendix giving some further discussion on the subject of rolling and dynamical stability.

The topics treated in the book show excellent judgment in the selection, and are such as every shipowner and officer should be familiar with. The treatment also is simple and clear, and avoids technicalities which would only be of interest to the naval architect or shipbuilder. On the whole the book seems to be such as should realize in high degree the purposes of the author, and it may be warmly commended to all those who are interested in an elementary discussion of ships and their nautical qualities.

Heat and Heat Engines. *A study of the principles which underlie the mechanical engineering of a power plant.* By Frederick Remsen Hutton, Columbia University. First Edition, 1899. John Wiley & Sons, New York; London, Chapman & Hall. Size, 6 by 9 1-4. Pages, 553. Profusely illustrated. Cloth, $5.00.

In this book we find the subject of thermodynamics and its applications to heat engines presented in an elementary manner, and as far as possible without the aid of calculus and higher mathematics. The book is intended as a natural sequel to the same author's earlier work on *The Mechanical Engineering of Power Plants.* The purpose in the earlier work was to present a general discussion of steam engines, boilers and accessory apparatus as found on the market and ready for selection by the power plant designer. No attempt was made, however, to discuss the questions involved in the design of such apparatus, and to quote from the author's preface to the present work:

"It was intended that the student should ask at the end of his study of that book: What are the principles of physics and dynamics upon which these machines depend; and how do engineers proceed when called upon to design such power-house engines? This book has been prepared to answer these questions in part. It discusses the energy resident in fuels, and the methods of its liberation as heat for power purposes; the transfer of such heat to convenient media whereby it can be used in heat-engines; the laws and properties of such media, and the design of cylinders of the necessary volume to give a desired mechanical effect or horsepower."

The mode of treatment adopted renders the development of the subject somewhat less logical and complete than might have been the case with the use of higher mathematics. This is fully realized by the author, who expresses the hope that the student will turn from the present work to further research in the higher field.

In general the subject matter of the book is well selected, and it is presented in a clear and instructive manner. The chapters on the steam engine give a good discussion of the theory of the engine, and a clear statement of the various losses to which the operations are subject, and the various means available for reducing or preventing them.

The book is well provided with diagrams and cuts, most of which seem to have been specially prepared for this work.

A brief bibliography is given in an appendix, in which the more important works in this field are noted. This for the student is a very useful feature, as he may here find references to the important literature of the subject, and may use it as a guide in his further studies in this field.

Notes on the Construction of Cranes and Lifting Machinery. By E. C. R. Marks. New and enlarged edition, 1899. Technical Publishing Co., Manchester; D. Van Nostrand & Co., New York. Size, 5 by 7 1-2. Pages, 183. With 155 illustrations. Cloth.

This book contains in some twenty-six chapters brief descriptions of the more common forms of lifting ma-

chinery, from the simple pulley block and plain crab to the more complicated forms of traveling crane and conveying apparatus.

The subject of hand-power hoisting machinery is first taken up, and the ordinary forms of rope pulley, hand crab, derrick, pillar and jib-crane, etc., are described and a brief discussion is given of the principles entering into the design of such machines, both as regards the proportions of the parts in order to fulfill the general purposes in view, and also as regards the dimensions necessary to safely carry the stresses to which they may be subject.

Passing next to power-driven machinery, the various forms of steam-driven hoists and cranes, both fixed and locomotive, are considered, and their essential features and structural arrangements are described. Good use is made here and elsewhere in the book of the principles of work and efficiency in discussing the relation of the capacity of the motor to the work to be done at the load end, and the relation between the speeds at the motor and at the load.

Mention is also made of warehouse elevators and cage lifts, the special subject of passenger elevators being only briefly touched on.

Overhead traveling shop cranes are next taken up, and the square shaft and rope-driven varieties are described, with brief mention of the electric crane. The latter type, which in the United States has almost completely driven other types from the field, is here disposed of in one-half page. In the last chapter, added as a feature of the present new edition, a few brief descriptions, taken mostly from patent specifications, are added relative to electric hoists. The lack of information relating to electric hoisting machinery is a defect in the book from the standpoint of the American reader, who would doubtless prefer present practice to a discussion of types which are here obsolete. The book is also incomplete in its discussion of the general problem of handling and transportation by machinery. The developments in the United States which have led to the systems for handling and transporting shipbuilding material, etc., to be found in most of our leading shipyards, or to the systems for loading and unloading ore, coal, grain, etc., especially at the chief lake ports, receive no attention. While the book is written presumably to cover British practice, it would surely be of more interest and value to its home readers if some notice were given of these systems of handling and transportation which are capable of accomplishing such astonishing results. From the standpoint of British practice, however, the book seems to fairly cover the field, and to give in a plain and readable style good descriptions of most of the forms of apparatus in common use.

The book is well provided with illustrations, most of which appear to be drawn to scale, and thus to give good ideas regarding the general proportion as well as the arrangement of the various parts.

Small Engines and Boilers. *A manual of concise and specific directions for the construction of small engines and boilers of modern types, from 5-horse power down to model sizes for amateurs and others interested in such work.* By Egbert P. Watson. D, Van Nostrand Co., New York, 1899. Size, 5 3-4 by 8 1-4. Pages, 108. With 30 working dimensioned drawings. Cloth, $1.25.

This book is intended chiefly for amateurs and students, on the assumption that those who need a guide of this kind have some acquaintance with ordinary machine work. The plans of the different size engines and boilers are carefully drawn, and have correct dimensions, and are so designed that they may be built with a limited number of small tools and still be mechanical jobs. The work contains hints on lathe work, vice work and finishing metals, which will be of service to those who have but a limited experience. The author lays particular stress on good workmanship in comparison with the tinker work which is too often employed in making working models. Several of the engines and boilers described are of sufficient size to drive a small boat or shop.

The Slide Valve Simply Explained. By W. J. Tennant. Revised and much enlarged by J. H. Kinealy, D.E. Spon & Chamberlain, 12 Cortlandt St., New York. 1899. Size, 5 by 5 1-2. With 41 original illustrations. Cloth, $1.00.

This work is based on notes and diagrams which were prepared by the writer originally to help his railway students toward the obtainment of clear general notions upon the important subject of the slide valve. Instead of using the complicated valve diagrams and formulæ he has endeavored to simplify the matter by a system of cardboard diagrams in which the successive positions of valve and crank can be closely followed. All the different working conditions of valves and effects of alterations to the same are discussed. The book is nicely illustrated, and different styles of modern valves are shown and their action described.

War History Monograph. *Part 26. The fighting about Candia between 1667-1669.* By Biggie. Issued under the authority of the German General Staff. Ernst Siegfried Mittler & Sons, Berlin, 1899. Pages, 114. With maps and plans.

This monograph is one of a series of war papers issued by the German General Staff, and deals with one phase of the long struggle between Venice and the Turkish power in Europe. While this war was chiefly naval, its interest is now, of course, historical rather than present day. The war ships in vogue in those times—the galley and high-sided sailing ship—are described with special reference to their use in the naval operations there carried on. The various features of the different campaigns are described with seemingly accurate and painstaking detail, while the maps and plans give additional aid in following clearly the descriptions of the text. The student of naval history should find in this monograph much of interest and value.

A very artistic souvenir of the participation of the American line ships in the Hispano-American war has been gotten out by the management. It consists of a paper-covered pamphlet richly illustrated with original drawings, sketches and photographs depicting scenes on and off the vessels *St. Paul*, *St. Louis*, *Harvard* and *Yale*. In the accompanying text the services of each vessel are recorded, together with a complete roster of the crews.

MARINE ENGINEERING.

Vol. 4. NEW YORK, DECEMBER, 1899. No. 6

Seventh General Meeting of the Society of NAVAL ARCHITECTS and MARINE ENGINEERS

FROM shipbuilding centers as widely apart as San Francisco and London representatives of both the naval and merchant branches of the profession gathered at the seventh general meeting of the Society of Naval Architects and Marine Engineers, November 16 and 17. This, as is customary, was held in the auditorium at engineering headquarters, 12 West 31st St., New York. There was a spring tide attendance, so that at the opening sessions informal overflow meetings were held in the assembly room, where acquaintanceships were renewed and the chances for debate were unrestricted. Some of the veterans were missing, but this was not surprising in these days of foreign active service and phenomenal shipbuilding activity at home. Even the President of the Society had to send his regrets across from the other side of the ocean, where matters connected with the expansion of shipping facilities had called him. In point of numbers there were substitutes, however, for all the absentees, and many unfamiliar faces betokened the vigorous growth of the Society. To Rear-Admiral F. M. Bunce, U. S. N., was assigned the honor of calling the meeting to order at the opening session.

ANNUAL REPORT OF SECRETARY-TREASURER.

Business matters occupied the attention of the members at the opening. The annual report of Secretary-Treasurer Francis T. Bowles, which had been indorsed by the Council, was presented for approval. This showed that at the date of the report, November 15, there were 573 members of all classes on the rolls. During the year twelve deaths had occurred, as follows:

George A. Barnard,	Sumner C. Paine,
Frank H. Conant,	W. Louis Sonntag, Jr.,
Jacob C. Cramp,	Frank Thomson,
R. B. Dashiell,	William H. Webb,
Alf. A. Dietrich, Germany	Charles P. Willard,
Robert R. Leitch,	Thomas W. Hyde.

Five resignations had been acted upon, as follows:

Members.	*Associates.*
Leopold Beck,	Benjamin H. Cramp.
Charles A. E. King,	William Swift.
George B. Whiting.	

Delinquent members numbered thirty-eight, their dues amounting to $268. A number of sales of back volumes of the Transactions were reported. The financial statement showed that the Society is prosperous. Receipts for the year were $5,614.76, which, added to the balance from the year previous, gave a total of $9,256.36. Expenditures for the year footed up $5,669.64, leaving a cash balance of $3,586.75 to carry forward. Resources, including fees due, volumes of Transactions, furniture, and cash invested and on hand, amount to $13,935.50, and the liabilities a minus quantity. By unanimous vote the report was approved.

ADMISSIONS TO MEMBERSHIP.

Many applications for membership in the several classes had been received and acted upon by the Council, and these were now presented to the meeting and a vote taken as follows:

Members—Arthur W. Ayer, Professor Mechanical Engineering, University of Vermont; Thomas W. Bristow, Consulting Ship Builder and Marine Expert, Cleveland; William F. Carnes, Assistant Superintending Engineer in charge of drawing rooms, Harlan & Hollingsworth Co.; George J. Carter, Manager Elswick Ship Yard; Sir W. G. Armstrong, Whitworth & Co., Ltd.; William G. Coxe, Guarantee Engineer, Wm. Cramp & Sons Co.; Robert K. Crank, Lieutenant U. S. N.; William Hessel

Marius de Gelder, Manager, L. Smit & Zoon Ship and Engine Building Works, Holland; William E. Elliott, Chief Engineer, Goodrich Transportation Co., Chicago; Eric H. Ewertz, Chief Constructor, Crescent Ship Yard; William Gatewood, Draughtsman, Wm. Cramp & Sons Co.; Elias Gunnell, Superintendent, Chicago Ship Building Co.; H. S. Hodge, President, Samuel F. Hodge & Co., Detroit; Carl O. Liljegren, Designer, Newport News Co.; Luther D. Lovekin, Chief Draughtsman, engine department, Wm. Cramp & Sons Co.; Alexander J. Maclean, Professor Naval Architecture, Webb's Academy; Henry Penton, Superintending Engineer, Chicago Ship Building Co.; William M. C. Philbrick, Draughtsman, Navy Yard, Portsmouth; Henry S. Ross, Captain, U. S. N.; John Roberts Sherwood, Vice-President and General Manager, Baltimore Steam Packet Co.; Harry G. Skinner, President, Wm. Skinner & Sons' Ship Building and Dry Dock Co.; Francis H. Stillman, proprietor the Watson-Stillman Co.; Gustave R. Tuska, Chief Engineer, Panama Railroad and Panama Steamship Line; Ogle T. Warren, Chief Draughtsman, Chicago Ship Building Co.; Philip Watts, Naval Architect and Managing Director, Elswick Ship Yard, Sir W. G. Armstrong, Whitworth & Co., Ltd.; Herman Wellenkamp, Royal Marine Shipmaster, Kiel, Germany; Alfred Westmacott, Assistant Constructor, Elswick Ship Yard, Sir W. G. Armstrong, Whitworth & Co., Ltd.; Charles J. F. M. Lilliehook, Professor of Naval Architecture, Royal Technical School, Stockholm; Herbert C. Sadler, Assistant Professor of Naval Architecture. University of Glasgow; Robert Curr, marine surveyor; Cleveland; Robert C. Monteagle, Chief Draughtsman, Burlee Dry Dock Co.; Charles E. Ward, Superintendent, Ward Engineering Works; Carroll S. Smith, New York Agent, William Cramp & Sons, S. & E. B. Co.; Howard Patterson, President New York Nautical College, New York; Mark Fargusson, in charge hull work, C. D. Mosher; Arthur Masters, Leading Draughtsman, Crescent Ship Yard; Friedrich Zeiter, Lecturer on Marine Engineering at Technikum, Bremen.

Advanced from Associate to Member—M. S. Chace, Assistant Inspector of Battleships, Newport News; Frederick Pomeroy Palen, Draughtsman in charge of Engine Department, Newport News Co.; William A. Fairburn, Chief Draughtsman, Bath Iron Works; Daniel C. Nutting, Assistant Naval Constructor, U. S. N.; Gowen Brooks, Chief Draughtsman, U. S. N., Bath Iron Works; Theodore Lucas, Calculating Draughtsman, Cramp's Ship Yard, Philadelphia.

Associate Members—Ernest A. Allan, Draughtsman, Bureau Construction and Repair, Navy Department; George E. Barrett, Draughtsman, Marine Department, Newport News Co.; Ralph E. Barry, Lieutenant, United States Navy, retired; Robert J. Boyd, Draughtsman, United States Navy, Geo. Lawley & Son, Corp.; Herbert Burton, Assistant Draughtsman, United States Navy, Columbian Iron Works; C. S. Butts, Draughtsman, Naval Station, Port Royal; H. G. Dalton, Pickands, Mather & Co., Cleveland; W. G. DuBose, Assistant Naval Constructor, U. S. N.; J. W. Duntley, President Chicago Pneumatic Tool Co.; Louis Eckert, Calculating Draughtsman, with Tams & Lemoine; E. F. Eggert, Assistant Naval Constructor, United States Navy; A. W. Goodrich, President Goodrich Transportation Co.; William G. Groesbeck, Assistant Naval Constructor, United States Navy; Albert R. Jackson, Engineer United States light house service; Alexander Kearny, Assistant Engineer of motive power Pennsylvania R. R. Co.; Otto B. Keller, with Keufell & Esser Co.; Gontran de Faramond de Lafajole, Lieutenant French Army; George E. Lawrence, Ship Draughtsman, Wm. Cramp & Sons Co.; William G. Mather, President Cleveland Cliffs Iron Co.; W. W. Meek, Draughtsman, United States Navy, Newport News Co.; L. T. Myers, Vice-President, Wm. R. Trigg Co.; W. C. Nickum, Leading Draughtsman, hull office Wm. Cramp & Sons Co.; Bernard F. O'Connor, New York; Charles L. Ottley Captain British Royal Navy; Hubert von Rebeur Paschwitz, Captain-Lieutenant, Imperial German Navy; Joseph W. Powell, Assistant Naval Constructor, United States Navy; W. G. Randle, Superintendent New York Ship Building Co.; J. R. Raymond, Secretary and Manager, Standard Automatic Releasing Hook Co.; Ernst F. Rossow, Draughtsman, Navy Yard, Mare Island; Henry H. Schulze, Draughtsman, Wm. R. Trigg Co.; H. T. Sloan, Engine Draughtsman, Pennsylvania R. R. Co.; Godfrey L. Smith, Scientific Department, Newport News Co.; Edward G. Todt, Chief Draughtsman, Engine Department, Chicago Ship Building Co.; G. R. Townsend, Draughtsman, Engine Department, Wm. R. Trigg Co.; B. W. Wells, Jr., Lieutenant United States Navy; A. B. Wolvin, General Manager American Steamship Co., Duluth; W. R. C. Wood, Hull Draughtsman, Navy Yard, New York; Allen D. Woods, Draughtsman, with Tams & Lamoine; William L. Wright, Assistant Draughtsman, United States Navy, Maryland Steel Co.; R. P. Adams, Draughtsman, Navy Yard, Norfolk; Theodorus S. Bailey, Draughtsman, United States Navy, Crescent Ship Yard; Thomas W. Battin, Chief Draughtsman, naval work, Newport News Co.; William B. Callison, Hull Draughtsman, Navy Yard, New York; W. S. Doran, Manager Marine Department, H. R. Worthington Co., Philadelphia; Isaiah C. Hanscom, Draughtsman, Navy Yard, Portsmouth; Edward McIntyre, Superintendent Spedden Ship Building Co.; Lucius M. Michael, Draughtsman, United States Navy, Harlan & Hollingsworth Co.; Isaac B. Mills, 156 Cypress street, Brookline, Mass.; Harold F. Norton, Draughtsman, United States Navy, Newport News Co.; J. W. L. Waters, Steel Hull Surveyor; Thomas E. Webb, Jr., Hull Draughtsman, Navy Yard, New York; John R. Gause, Assistant Constructor, hull department, Harlan & Hollingsworth Co., Wilmington, Del.; Henry S. Reed, with the Keasbey & Mattison Co.; Robert L. Ireland, Vice-President, American Ship Building Co., Cleveland; Charles Ackerman, Assistant Manager, Crescent Shipyard; William W. Ackerman, Secretary-Treasurer, Samuel F. Moore Sons Co.; Thomas Dolan, Director, William Cramp & Sons S. & E. B. Co.; George N. Gardiner, Member, George N. Gardiner & Sons; Charles Longstreth, V. Pt., U. S. Metallic Packing Co., Philadelphia; Maeston Niles, United States Navy, retired; Harrison I. Cole, Ship Draughtsman, Navy Yard, Boston, Mass.; Nicholas Cushing, Draughtsman, Crescent Shipyard; George B. Martin, Secretary, Crescent Shipyard; John E. Walsh, General Contractor; Frank P. Lewis, Master Electrician, Construction Department, Navy Department, New York.

Juniors—W. R. Ballard, Assistant Draughtsman,

United States Navy, Union Iron Works; W. R. Bean, Draughtsman, Newport News Co.; Louis A. Brooks, Draughtsman, United States Navy, Newport News Co.; L. D. Fisher, Draughtsman, Newport News Co.; Walter E. Kimball, Assistant Draughtsman, United States Navy, Fore River Engine Co.; James W. McCormack, Draughtsman, Navy Yard, New York; William S. Newell, Assistant in Marine Engineering, Massachusetts Institute of Technology; E. E. Pierce, Draughtsman, Newport News Co.; James J. Salmond, Assistant Editor, American Machinist; D. Stuart, Draughtsman, hull department, Delaware River Iron Ship Building Works; Edgar P. Trask, Draughtsman, Scientific Department, Newport News Co.; W. A. White, Ship Draughtsman, Newport News Co.; Frederick C. Whitehouse, Draughtsman, Navy Yard, New York; Charles Winterburn, Draughtsman, Navy Yard, Portsmouth; Walter S. Leland, Assistant Draughtsman, Navy Yard, Boston, Mass.; Stephen B. Boyd, Assistant Ship Draughtsman, Navy Yard, Boston, Mass.; Horace E. Setchell, Draughtsman, Engineering Department, Wm. Cramp & Sons S. & E. B. Co., Philadelphia; Eads Johnson, Draughtsman, Crescent Ship Yard; Austin E. Overmon, Copyist Draughtsman, Navy Yard, Boston, Mass.

It will be noticed that many foreign applications were received, including that of Philip Watts, the distinguished naval architect and managing director of the Elswick shipyard of Armstrong, Whitworth & Co., Captain Lonzdale Ottley of the British Navy, and residents of France, Germany and Holland. Applications from home centers represented very varied interests, coming from shipowners, shipbuilders, naval officers, designers, instructors, members of the technical staffs of various yards, and engineers in charge of construction and operation. This was a substantial evidence of the increasing interest now being taken in the higher development of the art, and the steady growth in membership and influence of the Society. Considerably more than 100 applicants in all were admitted to membership, and this brings the total membership up to 694 for all classes.

ELECTION OF OFFICERS, ETC.

Election of officers was next on the programme, and Mr. Ward was called to the chair. Secretary Bowles read the recommendations of the Council, which renominated the existing list of officers, and to fill vacancies occasioned by death named Rear-Admiral W. T. Sampson as First Vice-President and W. I. Babcock as Member of the Council. On the motion of John C. Tawresey the recommendations were unanimously accepted.

Rear-Admiral Bunce having returned to the Chair, resolutions of sympathy and regret touching the death of William H. Webb were introduced by Colonel Edwin A. Stevens, and those referring to the death of General Thomas W. Hyde were presented by Lewis Nixon and spread on the records.

The Chairman then announced the enforced absence of President Clement A. Griscom, who had been called abroad on important business, and in his absence the annual address would be read by the Secretary.

PRESIDENT'S ANNUAL ADDRESS.

"It is with sincere regret that I am obliged to present apologies for absence on this occasion, and to express by disappointment that urgent affairs require my presence in England at a time when I had anticipated the pleasure of taking part in what promises to be a most interesting meeting of your Society.

"This Society, now seven years old, emerges from a period of infancy at a propitious time, and the condition of its affairs is a subject of congratulation. Having been organized with about 430 members and associates, that number, by steady annual increments, has now reached 573, and at this meeting nearly one hundred more will be added to the roll. Your managers believe that the Society is of great value to the profession, and it is certain that the results are obtained at a minimum of expense to the members. It has been a subject of consideration whether the work of the Society could be long continued at the present annual dues, which are so much less than any other society of its class.

"The Society has suffered in this year the loss of its senior founder, that venerable dean of the shipbuilding profession in this country, Mr. William H. Webb, who has always taken part in our affairs with much interest. His achievements as a master of the art, his kindly presence, his devotion to the welfare of his fellow craftsmen, and the education of their apprentices, will long serve as a noble example to the members of this Society.

"Such remarks as it has been my pleasure to address to you from this Chair in past years have been, as I recall them, words of encouragement to progress and diligence in your work under conditions of trade which promised something in the near future but had hardly advanced beyond the state of theory. There is now with us, however, a condition of affairs in shipbuilding which is distinctly one of events and of substantial results.

"The Society will undoubtedly join me in congratulations to one of its members upon the masterful skill shown in the design of a certain yacht, whose record in the international races induces me to characterize this as the olumbia year for naval architects. Yet the immediate prospect of another challenge having its parallel in trade makes it necessary to caution you that all your energies are still required to meet certain conditions still adverse to the shipbuilding interests of our country.

"Whatever may be the political, moral or constitutional aspects of a policy of expansion, it is not without advantages to shipbuilders. The large number of vessels purchased by the Government last year for use of the Army and Navy, together with increasing use of steam vessels in the coasting trade have produced the greatest activity ever seen in our coast shipyards, both on the Atlantic and the Pacific Oceans.

"The orders for large steel steam vessels now taken exceed largely those of any year in our history.

"The record on the Great Lakes is such as to tax the capacity of the shipyards of that district until the fall of 1900. There are now building or to be built on the Lakes 26 steel vessels of large size of an aggregate value of about $8,000,000, and an aggregate carrying capacity of 154,000 gross tons. These vessels comprise one passenger vessel, two steel barges of 7,000 tons capacity each, five steamers of 3,000 tons capacity, suited to trade between the Great Lakes and the Atlantic Seaboard, and 18 steam freight vessels of about 6,000 tons capacity.

"We have also witnessed in the past year the entrance of Lake shipbuilders into the Atlantic trade.

"On the sea coasts we have the unusual condition of nine steamships building for ocean commerce. At least nine large steamers, recently built, have been added to the coasting or West Indian trade in the past year.

This is probably the first occasion that I have found any statistics in regard to American shipping industries of a character desirable to contemplate, and even now I feel obliged to accompany them with a note of warning, "One Swallow maketh not a Summer." The proportion of our export and import trade now carried in American bottoms is too small to be mentioned, and last year was smaller than ever before. To make this percentage a respectable one would require ten times the number of American shipyards working at full time for a number of years. While we have the materials, the tools and mechanics, the successful building of a modern vessel from a commercial point is in reality a triumph of organization of the multitude of diversified trades which it includes. This stage is yet to be reached and can only be attained by regular systematic production. Production depends upon a market and upon traders who see a profit to be made in shipowning under the laws of the United States."

First Technical Session.

The technical sessions were then commenced by the announcement of the chairman of the reading of the first paper:

COALING VESSELS AT SEA.

BY SPENCER MILLER.

This paper gives a brief synopsis of the various efforts in the direction of coaling naval vessels at sea which have been made in recent years, commencing with the plan of Lieutenant R. S. Lowry, R.N., in 1883, and ending with the method proposed by the author. Lieutenant Lowry employed special coal boxes, each of about one ton capacity and provided with an air tight chamber, so that it would float. The boxes were to be passed from the collier to the warship by lines, hoisted, emptied and returned. Later Lieutenant Bell, R.N., proposed a plan to fill the following requirements: Rapidity; safety; ability of the ships engaged in the operation to proceed with the minimum diminution of speed; necessity of keeping coal dry; minimum of labor to be employed; little cost for material necessitated. In the plan proposed by Lieutenant Bell, the collier would first be taken in tow by the warship; then inclined and elevated cables would be attached low down to the rear mast of the warship, and to the top of the foremast of the collier. On the elevated line a truck containing about five bags of coal would be run out to the war vessel and returned when empty, the to and fro movements of the truck being controlled by attached lines. The coal would he hoisted from the hold of the collier to the point of loading into the truck. In discussion, at the time, objection had been made to this system because of the lack of means for maintaining a uniform tension upon the elevated cable. "By the ships pitching toward each other the coal bags would likely be dropped into the sea," says the author, "and by pitching away from each other, either the foremast of the collier would be unshipped or the suspended cable snapped." A plan proposed by Lieutenant Tupper, R.N., contemplated the use of an endless chain passing from the collier to the warship and carrying baskets of coal, but this was subject to the same criticism as the plan of Lieutenant Bell. The plan of Philip B. Low, patented in 1893, was put to practical test by the U. S. Navy Department, the old U. S. S. *Kearsarge* being used in place of a collier to coal the U. S. S. *San Francisco.* This plan the author describes as practically the same as that proposed by Lieutenant Bell, R.N., but with the addition of a counterweight attached to the end of the elevated carrying cable, to maintain a constant tension. The test was made in a calm sea, the vessels being about 200 ft. apart. A counterweight weighing 1,600 lbs. was employed and the coal was contained in 200 lb. bags. The time of hoisting and sending 10 bags was 20 minutes, or at about the rate of 2 to 2 2-3 tons per hour. After the test the Naval Board reported that in rough weather the apparatus would not be of great value. Reference is then made by the author to the plan proposed by John E. Walsh, of New York, along somewhat similar lines and employing a counterweight, and he states the belief that "any hoisting device of this kind elevated to any height would be impracticable in a rolling sea." The author next refers to the paper by Lieutenant A. P. Niblack, U.S.N., read at a previous meeting of the society in which that officer appealed "for larger coal capacity and greater facility for getting coal into storage in our warships." He cited coaling records for the U. S. S. *Chicago, Charleston* and *Newark,* 30 tons an hours; H. M. S. *Thunderer,* 17 1-2 tons, and H. M. S. *Anson,* 51.6 tons, the latter using a Temperley transporter. Under specially favorable conditions a recent British test gave a record of 150 tons an hour. Following this an outline of the coaling operations of our fleet in Cuban waters is presented by Mr. Miller, giving references to accounts of damage done colliers by collision with the warships when broadside coaling was attempted at sea. He refers also to a dispatch of Admiral Schley, stating the necessity for leaving the harbor of Santiago unguarded and going to Nicholas Mole for the purpose of coaling his ships in smooth water. French experiments with the use of the Temperley transporter for coaling at sea are also referred to briefly, and this is followed by a disquistion by the late Vice-Admiral P. H. Colomb, R.N., on what may be termed briefly the strategical value of coal. In conclusion the author describes his form of conveyor which has been fitted on the U. S. S. *Marcullus,* collier. In operation the collier is taken in tow of the warship leaving a distance of about 300 ft. apart. The collier is fitted with a special form of winding engine located aft of the foremast, and from this a 3-4 in. cable leads to the top of the foremast over a sheave and thence to a sheave supported on shear legs on the warship, and back again to the mast and winding engine of the collier. This engine gives an in and out motion to the rope and to one side of the loop is attached a carriage with a capacity of 700 to 1,000 lbs. of coal. By an arrangement of friction drums the conveying distance between the two vessels is compensated for and a practically uniform tension sustained during the transit of the load. The total tension is expected not to exceed a maximum of 8,000 lbs., and the speed of conveying is about 1,000 ft. per minute. The paper is

accompanied by rough sketches and engravings of the various systems referred to.

DISCUSSION.

There was no general discussion upon this paper. John E. Walsh announced that he had a plan for coaling from a vessel alongside on the same principle, and called attention to a model, which he exhibited, of an apparatus for coaling at the stern.

CAUSES FOR THE ADOPTION OF WATER-TUBE BOILERS IN THE U. S. NAVY.

BY GEORGE W. MELVILLE, ENGINEER-IN-CHIEF, U.S.N.

In opening, the author announces the policy of the Naval Bureau of Steam Engineering—"the general adoption of water-tube boilers for all new vessels of our navy"—and refers to the existence of "a not inconsiderable sentiment in this country against water-tube boilers." Recognition of the seriousness of such a step is shown by the statement that "any important change in design, even of the apparently minor fittings of ships, may involve such risk to vessel and crew as to be unjustifiable unless the device be thoroughly tried beforehand." The author continuing states his desire "to show that the decision to use nothing but water-tube boilers in our future war vessels is a step in advance and a natural step toward the evolution of the perfect fighting machine." As to the water-tube boiler in its existing form the Engineer-in-Chief states it is bad in principle. Pressure is carried inside the tubes—the weakest part—while in the fire-tube boiler the pressure is without the tubes—tending to close a defective tube. Other defects named were: The decrease in amount of water in the boiler; increased difficulty of observing a leak; decreased value of heating surface. Special attention is also called to the fact that all vessels are compromises, and the author says "whether or not water-tube boilers are superior to cylindrical boilers, as boilers simply, if there be a beneficial effect upon the ship as a whole due to the adoption of water-tube boilers, these boilers are essential to the best design." Water-tube boilers are lighter than fire-tube, and of two similar ships fitted with water-tube and fire-tube boilers respectively, the former will be "somewhat the smaller and handier, will have somewhat less draft and will cost less." Little gain in space, but great saving in weight resulted from the employment of water-tube boilers. A few "historical facts" are next set forth, commencing with the use of the old Martin boiler in the U. S. Navy. In later days, U. S. torpedo craft were fitted with water-tube boilers, chiefly of the small bent tube type. Some accidents had occurred, due to carelessness of manufacture and not to defective design. Steam launches also similarly fitted gave much satisfaction, even with unskilled labor, and the record of mishaps was probably no greater than had fire-tube boilers been used. The first large installation of water-tube boilers was in the U. S. S. *Monterey*, which had four round Ward water-tube boilers, and two single ended fire-tube boilers. The water-tube boilers were satisfactory, little trouble was experienced in maintaining the water level and the boilers were retubed twice by the ship's force. A voyage of 8,000 knots was made by this ship, "largely under forced draft" without injury to the water-tube boilers, while combustion chambers of the fire-tube boilers were badly bulged. Installations of Yarrow boilers in the *Nashville* ("fairly successful"), and Babcock and Wilcox boilers in the *Marietta, Annapolis, Chicago* and monitors *Canonicus, Mahopac* and *Manhattan* ("thoroughly satisfactory"), were referred to. In the case of the monitors the water-tube boilers replaced old box boilers, the latter being cut to pieces and passed up the stack, down through which the separate portions of the water-tube boilers were passed in turn, and later assembled below. Ships to be fitted with water-tube boilers include: *Alert, Atlanta, Cincinnati, Wyoming* (Babcock and Wilcox), *Maine* and *Connecticut* (Niclausse), *Missouri, Wisconsin* and *Arkansas* (Thornycroft), and *Florida* (modified Normand). In operation water-tube boilers require ample feed pumps with easy regulation of feed. Heating surface per horse power of 2.4 sq. ft. is, in the author's opinion, as low as it is yet safe to go. As to economy, results from water-tube boilers of the latest design are as good as from the best type of cylindrical boilers. The ratio of heating surface to grate surface has been kept up to at least 40. A previous statement is qualified thus: "Water-tube boilers lose in efficiency when forced, especially those of the straight tube type"—not a matter of great moment in a war vessel, however, which is under forced draft only at maximum speed. No trouble was experienced from salt water or grease in water-tube boilers, and the author does not think impure feed or scale will cause more trouble in water-tube than in fire-tube boilers. Reference is made to the adoption of the water-tube boiler by the British and Japanese navies and also to reports of failures; no boiler, however could be properly said to have failed purely as a result of being a water-tube boiler. Failures may come from misuse, but not use. The author then recounts the "advantages" and "disadvantages" of the fire-tube and water-tube types, and refers to the capacity for raising steam quickly possessed by the latter, with the Santiago fight as a text. Higher pressures possible with water-tube boilers gave smaller and safer pipes and fittings and increased the efficiency of the engines. He opposed the use of boilers containing screwed joints in contact with the fire, or cast steel in the pressure parts. Ideal conditions were: straight and large tubes; few joints; no reducing valves; no automatic feed arrangements; ease of repair; lightness, in moderation; large ratio of grate to fire surface for complete boiler plant; large units; grates short, not too wide; thorough mixing of gases; free circulation; tubes not too long, with fire room space for ready removal. As to merchant ships and yachts, the author believes "it is at best a moot question whether cylindrical boilers are not still the best that can be fitted in ocean-going merchantmen."

In the absence of the author the paper was read by Walter M. McFarland, who added an experience of his own in point: "When I was attached to the *San Francisco*, our steam launch boiler blew up. Nobody was injured, and the only damage done was the carrying away of the top of the dome and the canopy of the boat. We had the boiler repaired at Kiel Dockyard, put in a new top to the dome and a few tubes, and used

the same boiler for some time afterward. When we were in England I had the pleasure of taking some of the people connected with *Engineering* out on a trip. After the trip was over and they were safe on shore I told them that that was the boiler which had blown up and had been repaired. It surprised them a good deal."

DISCUSSION.

George W. Dickie, of the Union Iron Works, said: "Somehow or another I have generally been placed amongst those who, if they did not actually oppose the introduction of water-tube boilers, lent no help whatever to their introduction. I would like to place myself right with the members of this Society in regard to that. I think I have wrought as hard, as honestly, and as long, as anyone here present for the betterment of water-tube boilers, and am still engaged in that good work. I do not quite like the tone of Admiral Melville's paper. I do not think that when he states that for tactical reasons water-tube boilers have been decided upon as the proper thing for the Navy, that he should make any apology whatever for their introduction. I am sorry that the Admiral should have stated in the paper that in his opinion water-tube boilers were mechanically bad and indefensible. I would not have gone that length even a few years ago. There has been a good deal of acrimonious talk and writing on both sides of the question of the introduction of the water-tube boiler, and I think that the advocates of the water-tube boilers have said as much and written as much in a violent sort of way as those who were most bitterly opposed to them. At a recent meeting of the Institution of Naval Architects one gentleman said that the trouble with Mr. Howden and Mr. Dickie—I don't know why he associated my name with Mr. Howden's—was that they imagined boilers were placed on board war ships for the purpose of generating steam. (Laughter.) Well we will have to admit that we had been laboring under that delusion, and no doubt the raising of steam has some connection, however remote it may be, with the placing of boilers on board ships. The Admiral gives a sort of an Irish rule that no change should be made in design that has not already been successfully made." (Laughter and applanse.)

Mr. McFarland: "He is Scotch, you know; he isn't Irish." (Laughter.)

Mr. Dickie: "However, I did not intend to find fault with that, because I think the Admiral is correct (laughter), that there should be a good deal more than the mere wish that the thing should be successful before it is introduced into any vessel. I think that was the Admiral's meaning.

"The Admiral speaks of the safety of the water-tube boiler and its lightness, and our friend Mr. McFarland who read the paper gave an instance of how simple a thing a boiler explosion was, and he spoke about the launch engine of the *San Francisco* that exploded. I am surprised that in these discussions in regard to water-tube boilers that we hear so much of boilers that exploded and did no harm—always with the inference that supposing the other one had exploded, what would it have done?"

Mr. McFarland: "I can tell you that, if you want it."

Mr. Dickie: "The other boilers on the *San Francisco* did not explode."

Mr. McFarland: "No, sir. I am glad they did not." (Laughter.)

Mr. Dickie: "There is a statement in this paper that I should like to ask some questions in regard to; that is the statement that the *Monterey* made a distance of 8,000 knots practically under forced draught; I presume that that refers to the trip that the *Monterey* made to Callao. Now the *Monterey's* bunker capacity is 200 tons, and she would steam about thirty-eight hours under forced draught, using all the coal that she had, and I can hardly accept the statement that the *Monterey* steamed any great length of time under forced draught during that trip. It is stated that the water-tube boilers did not suffer anything although the Scotch boiler combustion chambers were badly bulged. I think it is an unfortunate association that Scotch boilers sometimes get into, in regard to water-tube boilers. You know we suffer a good deal by being in bad company, and in that case the Scotch boiler may have been in bad company. (Laughter.) But in talking with the various engineers who have served on the *Monterey*, I find that invariably the Scotch boilers were used as auxiliary boilers when the vessel was in port. Unless it was an absolute necessity the water-tube boilers were not used. Before the *Monterey* went on that particular trip her Scotch boilers had been used for a month or two as auxiliary boilers and she may have gone out with them very dirty. The other boilers were not so used, and I understand that they are kept in reserve, and in good order, ready to be lighted up when they are required for the extra power. At the same time the water-tube boilers in the *Monterey*—and we speak of them because they have been quite a long while in the service—have undergone a very large amount of repairs, and they are reported now as requiring total renewal.

"I believe in the expression of the paper in regard to straight tube boilers and also in what has been said by Mr. See in regard to straight tube boilers, that the boiler that will be successful on our seagoing vessels will no doubt have straight tubes. The difficulty of replacing a tube that fails in a bent tube boiler is a very serious matter indeed.

"One point in Admiral Melville's paper that I noticed was that he deprecates the use of reducing valves. I am very much surprised at this, because I tried about two months ago to have them dispensed with on certain vessels and I could not get it done. I believe that a boiler that has to maintain a much higher pressure of steam than that used in the engines should not be used. A boiler to be a success must be able to steam at high pressure and give that steam dry, and the necessity of maintaining a much higher pressure in the boiler than is used in the engines is an evidence of a defect in the boiler that should be guarded against, and I think it can be guarded against.

"All criticism practically, so far as the introduction of these boilers in the Navy is concerned, is disarmed by the statement in the last paragraph of this paper that it has been decided upon for our naval vessels to use water-tube boilers because they give tactical advantages of great moment. I have been thinking a good deal about tactical advantages. I do not know what is meant here by that. I do not think that a vessel steers

any better because fitted with a water-tube boiler. I presume that it refers to the facility of getting steam rapidly when required. And, by the way, there is another point in the paper that may lead to a misunderstanding. In speaking of the conditions in front of Santiago the Admiral states that the *Massachusetts* might have been there and the *Indiana* might have kept up with the *Oregon* if they had been fitted with water-tube boilers. Now that paper has been written for those who know all about it; but these papers go where this thing may not be known. The *Oregon* was not fitted with water-tube boilers, and the inference would be that if the *Indiana* and *Massachusetts* had had water-tube boilers, like the *Oregon*, that they would have done quite as well. I presume that the *Oregon* had steam up and the others had not, and that was the whole matter, and the fact that steam can be readily got up in a water-tube boiler does not mean that a water-tube boiler will be ready for service as quick as steam is got. I think in a water-tube boiler it would be more difficult to get the fires in condition to supply steam for full power than to get the water hot enough to supply steam, and I believe that that is where the difficulty is going to arise. So far as tactical reasons are concerned, I think you step out of the frying pan into the fire, for the fire will then be your reserve of power instead of the boiler. In boilers with a large amount of water, such as the cylindrical boiler, kept under banked fires, the water has heat in it due to the pressure of steam and the engine can be readily started, and there is a few minutes leeway to get the fires in condition. You cannot do so with the water-tube boilers. And it is wonderful the ingenuity that has been displayed for providing all sorts of arrangements in these boilers in case of difficulty with the changing of power that takes place. In boilers we build now we fit them with very elaborate arrangements for putting the fires out in case the engine should be required to be stopped suddenly, or that for any reason steam should not be required. Otherwise the boiler would be empty of water.

"These are the points that have struck me in regard to the paper and the subject is an exceedingly interesting one—interesting, because it is going to play a very important part in the immediate future in regard to ship development. But I would like to state here and now that I do not think that the water-tube boiler that is to take the place, wholly, of the present Scotch boiler has yet come into existence. I think it has yet to be invented. That is my opinion, and I have studied this matter very carefully. The water-tube boiler can be arranged in a vast number of ways. It is covered in its various developments by innumerable patents. There is very little new in most of the boilers that come out. Ten years ago I laid down twenty-one designs for water-tube boilers. At the time that I presented a combination of water-tube and fire-tube boilers to Admiral Melville proposed for the war ships that were then being discussed and for which the plans were being prepared. At that time he was very much opposed to the very idea of a water-tube boiler and would not think even of one-half of the tubes being water-tubes. Out of those twenty-one plans I then prepared, sixteen have been patented since (laughter) and I am very sure that none of them are good." (Applause and laughter.)

NAVAL CONSTRUCTOR J. J. WOODWARD called attention to a feature, especially in connection with the use of the water-tube boiler—the need for large fresh water storage. This meant an increase of space so used and an increase of weight also. In the consideration of designs for large installations of water-tube boilers, this called for the most careful attention, not only of the engineer, but the hull designer. It was a matter which affected the question of stability. With water bottoms full, the water would act in a comparatively solid mass, with the center of gravity very low. In the process of emptying the bottoms the water surface would be considerably enlarged, with the result that the metacenter of that body of water would be relatively much higher than the space in which the water was confined. The practical result of beginning to pump out the tanks would be to raise the water from the tank to a position a number of feet above—a condition which might become a very serious matter in a warship.

JOHN PLATT in discussion of the paper said: "In referring to the objection made in England to the introduction of the water-tube boiler into the British navy, the Admiral was speaking from the knowledge that a very great deal of exception had been taken there, and that the engineers of the navy had been very seriously attacked for putting so many water-tube boilers into the large ships. There was some ground for that attack from the fact that in quite a number of the large ships breakdowns did take place, and sometimes rather serious ones. This summer I studied the whole matter for four or five months in England and abroad and found out, as nearly as I could, exactly what had taken place. Now it is all based upon the question of the form of boiler used, and I myself have been forced to the conclusion, very much as given forth by Mr. Dickie, that the water-tube boiler which will fulfil all the things we are looking for in a good boiler has not yet been designed. The boilers in England, in the large ships, which have been criticised all the way through, are boilers that fulfil more nearly the requirements as set forth by Admiral Melville—namely, boilers with large straight tubes. There are three of four kinds that have been used in the British navy; one very extensively; the others have only been tried, but in almost all cases they have given trouble. They are straight tube boilers when they are built, but after they have been run—especially if the boilers are ever forced—they are no longer straight tube boilers, and that is the trouble. In a fast battleship or fast cruiser, where you are getting very big power in a limited space, forcing is absolutely necessary; and when you do that with those large tube boilers and they come back, if they have ever been in a heavy sea-way, the tubes are not straight. I know in the case of a number of the British ships that the amount of deflection was very material indeed, and it was this deflection, and the lighting up of the fires again, which led to some of the more serious accidents in the ships by breaking the headers. That being the case, it is a question whether a boiler with a bent tube is as bad a thing as seems to be made out. Some of them have been in use for a very long time now. In the case of the British gunboat *Speedy*, I

saw the boilers of that boat this summer and they had been in use pretty constantly for six years. A set of the tubes were taken out (these boilers were used under forced draught, a pretty high forced draught, most of the time), and the tubes were cut through the middle. Now those boilers were built as torpedo boat boilers were formerly built, with very thin tubes, and they were really good enough to have gone on for another commission. But with that class of boiler, for a large ship, they would now put in very much thicker tubes. The tubes being bent the expansion and contraction are taken care of and that also removes one of the difficulties set forth as being a disadvantage with the water-tube boiler—namely, that the units are too small. Now with a large tube boiler as at present designed—any one of them, I don't care which it is—you cannot get a big unit for a war vessel. Take some of the recent battleships building—twenty-four to thirty boilers, having 16,000 or 18,000 horse power. With the large bent tube type of boiler, two of the battleships are being built with only twelve units, and that is possible and it is only possible under those conditions."

F. L. DuBosque spoke of the water-tube boiler applied to ferryboat service: "The old system of propelling ferryboats with low pressure steam was to provide boilers that were practically a little more than half of the full power required of the engines. Ferryboats ususally lie in the slip nearly as long as they run, and with a boiler of this capacity enough steam is generated to carry the boat across the river, and the pressure falls. When the boat lies in the slip the pressure rises and enough steam is generated to carry it back again. The great advantage of high pressure steam for propulsion brought forward its adoption on ferryboats, and at once it was seen that the old system of stored energy could not be followed. It is practical, to a large extent, on boats that lie in the slip nearly as long as they steam. But in the case of ferryboats of high speed that are in operation, say, 75 per cent of the time, and lie idle in the slip 25 per cent of the time, an entirely different problem is before us. In vessels of this type we believe it is practically impossible to use high pressure cylindrical boilers. If the service calls for 2,000 horse power to be generated during all the time that the boat is running, it is impossible with a shell boiler to shut off the generation of the 2,000 horse power while the boat is lying in the slip. You can also see that for a boat that is running 75 per cent of its time, in the other 25 per cent it is impossible to store enough energy to enable her to complete the trip. Therefore the water-tube boiler seems to be a very proper thing in such service. Those boilers have been used on some of the ferryboats in the harbor here for the past three years, and the theory has been carried out very nicely. The boats were able to maintain (where the boilers are large enough) the full power and pressure for 75 per cent of the time. For the other 25 per cent, when they lie in the slip, because of their flexibility and the easy control of the firing, the drafts can be closed, and the boiler practically supplies only enough steam to run the auxiliaries. One principal reason, I should have stated first, for having these boilers is to avoid blowing off steam. It might be said that steam could be blown off either into the condenser or into the atmosphere—we all realize that that would be a waste of heat. On the ferryboats that have water-tube boilers, we have come to the conclusion that there is a saving of from 15 to 18 per cent in fuel by their use."

W. D. Forbes said in his experience the water-tube boiler wears out exactly like the "one-horse shay." It all goes to pieces in a few minutes, but is very easy to repair. The expanding of tubes can now be readily carried out. He had found, however, that in rolling the small tubes in these boilers, so as to get them tight and have them remain tight, it was impossible to do so very quickly. It seemed to demand time for the metal to flow. Expanding a tube with a speed of rotation of, say, twenty or thirty turns a minute would momentarily tighten the tube, but the slightest subsequent strain would start a leak. He was surprised at the lack of provision for keeping the outside of the tubes clean, other than a little door and a nice apparatus on the end of a hose to blow out the dirt. This was not effective, and it would be easy to introduce a system in which, by simply turning valves, the dirt would be blown from the top drums and all parts of the tubes down to the bottom of the lower drums into a suitable receptacle. In repairing boilers used during the Spanish war he had found that from the lower drum up as high as he could reach they were "absolutely solid with dirt." The interior of the tubes, on the contrary, were spotlessly clean and there was nothing to show that there was any danger from stoppage, though this had been feared. The outsides of the tubes were pitted and eaten up for lack of any provision for cleaning. In reply to a remark of Mr. Dickie, the speaker said: "I believe there is a vast difference between the steering of a boat with cylindrical boilers and one with water-tube boilers. At the end of the first ten minutes one would have no use for steering, as she would lie idle, while the other would be under way and would naturally have to be steered."

Mr. See said the principle on which the water-tube boiler was founded was sound. The elements entering into the construction of the cylindrical boiler were more numerous and more dangerous than those entering into the construction of the water-tube boiler. The tube existed in the former as well as the latter, and was subject to the same causes that produced decay and injury. In addition there were furnaces liable to collapse, a combustion chamber subject to eating away and leakage at the joints, and the large shell subject to injury at the joints, and also from unequal expansion and contraction of its thick plates. He believed that in the water-tube boiler, unless the tubes were submerged, or arranged to let the water come in close contact with all the parts subjected to hot gases, they would suffer more rapid deterioration or become loosened at the ends. As to the bulging of the drums of the *Nashville's* water-tube boilers, this should not be charged to the type, for this had happened to all boilers where the gases were allowed to come in contact with the metal, where only steam and hot water were against the other side. The boiler with straight submerged tubes and no steam space exposed to the gases possessed greater advantages than those enumerated by the author.

Mr. McFarland, in responding for the author at the close of the discussion, referred to the statement of

Mr. Woodward regarding the fresh water supply. He did not know that an adequate supply of fresh water was more needed in the case of the water tube boiler than with the cylindrical boiler. It was a fact that the necessity for such reserve supply had been recognized, though in the past no such special provision had been made. If, however, an adequate make-up arrangement with a small reserve space was fitted, it probably would amount to the same thing in both cases. He was sure Admiral Melville would be very much pleased with the discussion that the paper had brought out.

SUGGESTIONS AS TO IMPROVED APPLIANCES FOR LAUNCHING SHIPS' BOATS.

BY JOHN HYSLOP.

In introducing his subject the author makes this statement: "It yet remains that the vast development of ocean travel in the past half century and the increased water traffic of every kind has been unattended, except in rare instances, by any change whatever in the method of launching ships' boats." As causes for this remarkable situation he gives: "Lack of technical knowledge on the part of those with whom has rested the adoption of new propositions, and a consequent want of confidence in any estimate they ought to make of the value of such propositions, or of the possibility of effecting any amendment;" also remoteness of marine disasters from public observation, and in many instances total disappearances of vessel and crew. The author was one of the survivors of the *Mohegan* disaster, which occurred on the night of October 14, 1898, and resulted in the loss of many lives. To this he probably refers, though not by name, in these words: "It was most distressing to see 150 men, women and children waiting through ten or fifteen minutes, each elapsed minute narrowing the limit of life for over two-thirds of that number, only one boat being got clear of the ship, and that one in a damaged condition." Boats have been put afloat from a ship's deck within three minutes from the time the order was given, under the most favorable conditions: In daylight, ship neither rolling nor listed, boat handled exclusively by sailors. On one of the largest transatlantic steamers, however, which was well equipped with boats in the usual way, the question was asked: "What could you do if the vessel was rolling or listed?" and the reply of one of the officers was: "We know we could not launch them at all." Ordinary davits and heavy boats could not be swung out in heavy weather, nor when a vessel is listed. From experience and actual occurrence the author knew that such attempts were attended with loss of life or limb. "It appears both interesting and instructive," he continued, "to inquire how far it is practicable to carry ships' boats inside the lines of a ship's sides, and yet at all times outside the davits, and also to inquire if any better means can be used to operate and control the present common form of davit." Reference is then made to the Mallory davit patented in 1871-73. In this form the davits are hinged at the lower end and the boats, though inboard, are carried outside the davits. An angle iron frame extends in an inverted L outward from the top of the deckhouse to the beam ends, and then downward to the ship's side. On top of this frame the boat is carried in chocks, and when raised from its seat the davits falling outward carry the boat clear of the ship's side, their outward movement being controlled by falls to the extreme outboard position, which is fixed by the frame referred to. The davits are of rectangular cross section. An objection to this form is the necessity for stretching a tackle from each davit across the deck to regulate its outboard movement. The author proposes a more compact and permanent winch arrangement which would be always ready for operation, and with which, by turning a crank handle, the boat would be raised from its seat and the davits moved in an outboard direction at one and the same time. Reference is also made to the device patented by Sir Bradford Leslie, of Falmouth, England, which provides a cradle for carrying the boat inboard, the cradle being supported on top of a long arm or davit which is carried down outside the ship's side and hinged above the water line. To operate this device the davits are lowered vertically, the hinged end working in a slide, until the boat is brought down to a convenient height to load from the deck, then the davits are allowed to fall gradually outward, the boat traveling through an arc of a circle, and when the water level is reached the boat floats off. The outward movement of the davits is supposed to be controlled by a wire rope wound around a drum on the deck and suitably braked. Details which in the opinion of the author demand attention are: Wooden vs. metal boats; cork fenders; chocks and releasing tackle; gripes and davit guys; detaching hooks. The location of the boats with respect to the rail, and methods for covering and securing boats so that they may be readily prepared for launching, also the control of davit movement by worm gear, are discussed. In conclusion the author states that if no advance over present methods is made, he would, from past experiences, prefer to depend on swimming or on a floating hatch, spar or plank for safety, rather than upon the likelihood of getting boats properly afloat in a short period of time.

Upon reading the paper the author exhibited a small model of his proposed system and pointed out that it would hold the davits and boat at any particular point in their outboard movement. With the ordinary methods it was very difficult to control the movements of the boat when the vessel was rolling. The boat was usually very heavy and there were but few men to get it out. On a liner, while eight or ten men would probably be assigned to each boat, the number would not include more than two sailers, the others would be from the steward's and engineer's departments. In a case in his experience in lowering a boat with ordinary appliances one man was seriously injured and another crushed to death, between the boat and the rail, when the boat swung in.

DISCUSSION.

JAMES R. RAYMOND, in a communication, called attention to the great power and consequent responsibility placed by law in the United States Board of Supervising Inspectors of Steam Vessels in the matter of providing life-saving appliances on passenger steamers. After referring to the Federal laws governing the case, he adds:

"The law entrusts this board with the selection and

enforcement of such measures as will best secure the safety of persons traveling by water; and it also, in terms positive, instructs how it shall be done. The Board of Supervising Inspectors should, therefore, be eager to determine the best appliances for the purpose and enforce their use without fear or favor. But it is plain to anyone familiar with the proceedings of the Board relative to detaching apparatus that they have aimed to do as little as possible, and have shown no disposition whatever to comply with the law, and in so doing, inferentially at least, serve the pecuniary interests of the steam vessel owners, rather than those whose lives depend upon the selection of the best means extant for the preservation of human life on shipboard. In substantiation of this it is only necessary to consider the number of passenger steamers provided with no detaching apparatus whatever other than the antiquated hook and ring, which cannot be considered to be a detaching apparatus in compliance with the specific requirements of the law; and to consider the further fact that some detaching devices which the board, according to the record of their proceedings, have condemned as death traps and whose only recommendation is their cheapness, are allowed to remain in use, to have their defects discovered only in time of disaster.

"The Supervising Inspector-General has asked that the statutes be amended so that the Board might be enabled to select a proper device, claiming as a reason that, according to the wording of the statutes, they are prevented from giving their approval of any device other than the one mentioned therein, namely, the one operated by one person, disengaging both ends of the boat simultaneously, etc., etc. Had he the welfare of the public at heart would he, or the Board of Inspectors under him, find anything in the language of the statutes that would forbid the selection of any good device, the universal use of which would familiarize all sailors with its operation? Would not the enforced use of a good device, so selected, prevent the terrible blunders and loss of life now so often occurring in emergencies, because of the use of a multiplicity of defective devices?"

He closed with a plea for a thorough examination by a competent body of men into the whole subject of launching ships' boats.

Secretary Francis T. Bowles said the paper just read had been prepared in response to a public request from the Society for contributions relating to the subject of saving life at sea, and he expressed to Mr. Hyslop the pleasure and gratitude of the members which the reading of the paper occasioned, and for the suggestions which it contained.

Second Technical Session.

Rear-Admiral Bunce, U.S.N., again occupied the chair when the meeting was called to order at 2.45 o'clock on Thursday afternoon. He announced the continuation of the discussion on the paper read by Mr. Hyslop.

William P. Stephens spoke of the importance of the paper, referring briefly to the recent loss of the *Charleston* and the burning of the *Patria.* He suggested the appointment by a committee to proceed with the investigation of the subject.

Captain Randall, in discussion, said: It has been my good fortune to have been in command of transatlantic liners for the last twenty-five or thirty years. During that time I have witnessed many serious mishaps occasioned by the lack of a speedy device for detaching boats from the sides of ships. The last serious mishap that I observed was when, in command of the *St. Louis,* I was able to save 243 lives from the *Veendam* of the Netherlands line. It was on a dark night and in a stormy sea. We succeeded in lowering four of our life-boats and finally, in three hours, we rescued those people. Fortunately our appliances were very good. But in the work of rescue we smashed in two or three of our boats from the sudden rolling of the ship. After we had swung them out they then rapidly came in before we could lower them down, and smashed the whole side in. It brought very prominently to my notice that we were at fault in having ships' boats hanging to davits at all. Some other method should be applied or invented whereby we could readily detach the boat from the ship, and the idea has occurred to me many times that a boat kept in a depressing cradle athwartships of the ship, that could be readily launched end on overboard, would be the most feasible method of launching a boat from a ship. It requires neither davits nor tackles nor detaching apparatus. It could be placed on an athwartship cradle on a kind of launching way; and by depressing the cradle on whichever side you wished to launch the boat it could be readily slipped overboard. It would make no difference whether the ship had five degrees of list, or twenty or more, or even up to an angle of forty degrees. Supposing that a ship in collision had water suddenly brought in on the one side or the other, the boats on one side of the ship, under the present method, are entirely useless, whilst the other side is very often almost in the water, as was the case with the *Elbe* when she was sunk by collision in the North Sea, and many others I could cite.

"Ships' boats should be of greater capacity than now; they should be double bottom boats. They should be also rounded at each end so that they could be launched readily overboard, and it is surprising how little water will go into a boat when it is launched end on overboard; I have tried it many times myself. I saw a boat launched once in that way when the ship was going at the rate of ten knots and not more than a hogshead of water got into that boat and she readily cleared herself by having this double bottom and movable plugs in the bottom of the boat. I saw the boat launched repeatedly under those circumstances, and she was off and afloat, and by a long painter was brought alongside of the ship—that boat had a capacity of a hundred persons."

The speaker favored further action by the society.

Francis T. Bowles said that rather curiously the same idea of launching boats had occurred to him, but he had refrained from proposing it, as it had seemed to him so unseamanlike. Now, however, that the suggestion had come from Captain Randall, whose experience had been very great, indeed, he believed that it ought to be developed and carried out. Boats should be stowed athwartships instead of fore and aft as now, and they should be made of larger capacity. It was well known that boats were more seaworthy in proportion to their size. A simple means of launching should

also be provided—a method somewhat similar to "shooting the chutes."

John Hyslop, in responding, reported a recent conversation he had had with a chief officer of a transatlantic liner, who, in reference to the matter of boats, said: "If I had my way we would not have more than four boats," and in explanation, continued, "we could never launch them; everything would be confusion. They are a bother. They are in the way. My opinion is that the safest thing in the case of a calamity would be for a person to keep quiet, and the person who kept the quietest and who was in the least bit of a hurry would have the best chance—on a plank or something of that sort." Continuing, the speaker said that no matter what care and forethought were exercised, accidents would happen to vessels which human ingenuity could not foresee. He referred in brief to the recent collision between the *City of Rome* and an iceberg, and the danger from striking ocean derelicts. A good, stout ship's boat once properly afloat would weather any storm and he instanced the case of the S.S. *London*, where an officer and several men were put afloat in a boat during a severe storm in the Bay of Biscay. The captain gave them the course and they reached land in safety, while the vessel went down. He urged that the Society appoint a committee out of its membership to consider the question.

Naval Constructor W. L. Capps said the appointment of a committee presented many obstacles. There were many subjects of great importance to be considered, and he believed the question of a committee should be referred to the Executive Committee with power to act. They could either act as a committee or appoint a special committee to consider the matter. He called attention to the "most effective incentive to development of this kind" which had been offered by the heirs of the late Anthony Pollock, of Washington. Through the French Government they offered a prize of, he believed, 100,000 francs for the best plan of saving life at sea. Without doubt within a year there would be a multitude of suggestions, many of them good, to that end. He moved that the matter be referred.

E. Platt Stratton told of the landing of surf boats in high seas, which was accomplished in safety owing to the skill of the crew. One difficulty in launching boats was want of skill in the boat after she struck the water. The best disengaging apparatus that he knew of was that which automatically disengaged both ends of the boat at the same time—and this could be done while a vessel was moving at speed. He suggested that each ship carry a certain number of skilled surfmen who would act as captains of the boats.

W. P. Stephens seconded Mr. Capp's motion and it was put by the chair and carried.

ELECTRIC PLANTS OF THE BATTLESHIPS KEARSARGE AND KENTUCKY.

BY NAVAL CONSTRUCTOR J. J. WOODWARD, U. S. N.

This is a paper descriptive of the most extensive installation of electric auxiliary machinery yet attempted on any vessels of the United States navy. Tests and the resulting record of efficiencies are not included, as the installation of the apparatus was only partially completed at the time the paper was written, but the author expresses the hope of making a further and later contribution to the Society dealing with these matters. The installation on these battleships covers the range of auxiliaries for the general service of the vessels, with the exceptions of windlass and steering gear, and does not extend to the engine room auxiliaries. Thus the author comments that these plants can only be regarded as an intermediate step between the complete steam drive for auxiliary machinery and the complete electric drive for all auxiliary machinery in the ship—"whose adoption appears to be a possibility of the future." The most serious limitation to the extension of the electric drive is the time necessary for the officers to instruct the members of the crews who would be intrusted with the immediate care and manipulation of the electric apparatus. While the installations on the two ships represent a concentration of electrical devices, yet these, in a cruder form, have been in operation separately on many ships of the navy —among such come turret turning gear, ammunition hoists, blowers, etc. The satisfactory working of these minor installations, even in action, is referred to as an answer to expressed doubts whether the systems on the two new ships can be maintained in a constant state of high efficiency. Brief reference is made to the electric equipment of the Russian warships building here, in these ships electricity being substituted for steam as motive power for all auxiliaries both in the engine room and above decks, with the result that large and economical units are employed in the generating plant. Work to be performed on the *Kearsarge* and *Kentucky* by the electric plants includes: Ship lighting; search lights; signal sets for working the ship and for distant communication; running lights and lanterns; turret equipment; turning, hoisting, gun working, ventilating gear; independent ammunition hoists; deck winches; boat cranes; ship ventilation; in connection with steam steering gear. The method of distribution is the Edison three-wire system, allowing the use of two pressures—80 and 160 volts. The ship wiring can be so connected as to operate any motor on the ordinary two-wire system at a reduction of one-half its capacity. The generating plant is located below the protective deck, between the inner wing bulkheads, and is disposed in three sections. On a platform three dynamos are carried and below this there are two compartments divided by the center line bulkhead, in each of which there are two dynamos—seven in all. These machines are six-pole, fifty-kilowatt, eighty-volt, compound wound dynamos, each driven by a direct connected, vertical, tandem compound, single crank, engine running 310 R.P.M., with 100 lbs. steam pressure and 25 in. vacuum. The lowest pressure at which the engine will carry the full load is 80 lb. and 25 in., and it will carry an overload of 50 per cent if need be, also being capable of operation with steam up to 150 lb. pressure. The cylinders are 10 1-2 in. and 18 in. by 8 in. stroke. Two balanced piston valves and fly-wheel governor are fitted. Very complete oiling devices are supplied and the engine is completely enclosed so that no splashing is possible. Each generator has, supported from the upper frame, a connection head board provided with suitable switches and circuit

breaker, from which all cables and field and pressure wires are led. The main generator switch board is located on the platform in the dynamo room and consists of seven slate panels, containing an ammeter, switches, and a rheostat for each generator, and one instrument panel, with volt meters, ground detectors and lighting switch for the dynamo room circuit. From the switch board busbars feeders run to three separate distribution boards which are situated on the splinter deck, one forward, one amidships and one aft. These in turn are connected with seven auxiliary distribution boards used for power purposes only, which give convenient centers of distribution and reduce the number of wires that would be required if each motor were fed individually from the main distribution boards. The paper gives a detailed account of the scheme of current sub-division to perform the numerous functions of lighting and power, and also a general description of the controlling appliances and the mechanical application of the electrical energy to accomplish the desired results. Many valuable plans, detailed drawings and engravings accompany the paper.

DISCUSSION.

Charles J. Dougherty said: "The three-wire system is new in our navy and it gives two pressures and also allows a saving in copper, but this must be balanced against the simplicity which is in the two-wire system. In the three-wire system it seems to be acknowledged that there is more complication than in the present two-wire system. In other words we must educate our men in the navy to take care of the complications required by the three-wire system, acknowledged to be more complicated than the two-wire system.

"Another thing, which is very interesting, is that the ships which foreign powers are having built in this country are being equipped more completely, electrically, than those of our navy, and it becomes necessary for the engineer charged with the duty of selecting a system to weigh carefully the advantage of one system as against the other. Consequently he should look at the other side as well as the good side, which is always pushed forward. First of all, balancing of the three-wire system is almost always necessary. Unless great care is taken the lamps on one side will be higher in voltage than on the other and there would be winking.

"In regard to the concentration of circuits on the *Kearsarge* and *Kentucky*, we find that distributing panels have been located in the forward and after part of the boat, and consequently the circuits are much smaller; the number of bulkheads pierced is less and it is a very good idea, I think.

"As I said before, the three-wire system is more complicated. Another thing about the three-wire system is that there are grounds and when grounds occur on a three-wire system it is impossible to locate them, and the insulation capacity of the plant is reduced, because the potential is now 160 where it used to be 80. This is something we should look into. It is acknowledged to be more difficult to insulate at 160 than at 80. I think we should first see how the plants of the *Kearsarge* and the *Kentucky* are working, for a year or so, before we draw conclusions whether the system is a perfect system or whether the system should be considered in further installations. When you consider that, as I said, foreign powers are having vessels built in this country, and electric plants are increasing all the time, we should look for a better system, and if the three-wire system is the best system to install, I say by all means introduce it on board every ship that we have in the navy."

Captain Randle said that in 1883 he was at Laird's yard in Birkenhead superintending the construction of two ships for the Red Star Line. At that time electricity was not much used on vessels, only one ship, the *City of Berlin*, having a very primitive lighting plant. It was decided to install electric lighting plants in the two new ships and the machines were provided by Siemens of London. In one ship there were 400 incandescent lamps, and in the other 300 lamps. In both vessels both generators were put in the most convenient places without regard to their working conditions. That in the *Westernland* was placed on a platform in the forward part of the engine room just above the cylinders—the hottest place in the ship. The lights on the *Westernland* proved to be very inefficient. On the *Noordland*, however, the dynamos were placed in the after part of the engine room, and they ran cool and pleasantly and the lighting was most satisfactory. Explaining this he said the direction of the currents of air through a ship while in motion was a matter not generally understood. Ships are fitted out in shipyards while lying still, and it is not generally known by experts in shipyards that a current of air below decks is in the reverse direction to that in which the ship is traveling. "When it is blowing a gale of wind and the ship is going ahead, the current of air below decks is directly toward the bow, and therefore all heated currents, no matter where they originate in a ship, are flowing towards the forward bulkhead." This explained the poor working of the plant on the *Westernland* where the dynamo located at the forward end of the engine room received all the heated air, while in the *Noordland*, with the conditions exactly reversed, the plant worked perfectly. With regard to the *Kentucky* and *Kearsarge*, he considered the location of the dynamos near the boilers faulty and suggested that the electric plant should be placed as far from the engines and boilers as possible. In any given compartment dynamos should be placed against the after bulkhead, so that the heated air would flow away from them.

S. Dana Green referred to the paper as "the most complete and comprehensive of the kind ever prepared," and further said: "I think the author is to be congratulated upon having given such great care to the minor details of construction of the various motors and their mechanical application to the auxiliaries of the *Kearsarge* and *Kentucky;* because I am thoroughly in accord with him in believing that a great deal of the success of the operation of the auxiliaries in practice depends on these details.

"The question presented by this paper really brings up a much broader one than the mere application of these auxiliaries on board the *Kearsarge* and *Kentucky*, because it is the beginning of a step which, if carried out to its logical conclusion will mean the electric drive

for all auxiliaries on board ship. It is a subject that I have been interested in for a number of years and to which I have given considerable thought and study, both on account of my former connection with the Navy and on account of my active connection at the present time with electric work. Its success, and therefore its ultimate adoption in the service, must depend on the results which are obtained in practice in the service in the *Kearsarge* and *Kentucky*, because those are the first two ships of our service where the system has been employed to any great extent.

"There are two main features to be considered, it seems to me. One is the question of reliability, and the other, ease of manipulation. If the apparatus is not reliable and is so delicate that it cannot be handled by the class of men on board ship, no matter what its economy, whether estimated or actual, may prove to be, it is going to be thrown out—it ought to be thrown out. And if it is uneconomical, so that the coal endurance of the ship is reduced or her steaming capacity reduced, it should also be thrown out. I firmly believe that the electric drive will prove its superiority in both of these respects.

"I think that Mr. Woodward is right in saying that one handicap which the navy is under at the present time, is the lack of sufficient officers and men who have enough practical knowledge of the electrical apparatus to handle these various appliances on a ship to-day. But I think the same thing may be said about a great many things that go on board ship to-day; we have not got men enough who are familiar with the latest appliances, and I think the men ought to be taught about those appliances. The Government should provide schools for that purpose, just as schools are provided on shore for instruction in other branches, if the Government is going into the electric drive. I am not sure that that is an objection that can be considered a permanent one. It may be an inconvenience at the present time.

"So far as reliability is concerned I am equally sure from the experience that we have already had on board ship and from the operation of electric motors in such service, for instance, as street car service on shore, that the motors that have been put on board the *Kearsarge* will stand the test of service.

"There is another advantage, of course, in the electric drive with reference to the circuits running about the ship, which to my mind has a decided importance from a military standpoint, and that is the question of wires versus pipes. We all know how demoralizing the bursting of a steam pipe is, either in time of peace or in time of war, under high pressure, and it seems to me exceedingly likely that in a severe engagement, especially of unarmored ships, one or more of the steampipes, or circuits, whatever they may be, whether wires or pipes, are liable to be hit. Of course, if a wire is broken by a shell it may disable an auxiliary just as the breaking of a steampipe would; but the damage will end there, and it is easier to repair, as well as being harder to hit in the first place.

"On the question of economy, in a paper which I read before the American Institute of Electrical Engineers last winter, I made the statement that taking the most modern electrical apparatus and the most modern steam apparatus, the economy of steam consumption at the auxiliary was about as two to one in favor of the electrical apparatus. That is to say, there are makers of electrical apparatus to-day prepared to guarantee 40 lb. of water per indicated brake horse power at the auxiliary. Many present are familiar with the result obtained from a series of tests on the *Minneapolis*. We tested her auxiliaries on a cruise from Gibraltar to Philadelphia, two or three years ago, where the main engine economy was shown to be 20 lb. of water per indicated horse power and the auxiliary 119 lb. of water. That test, I think, was one of the things which drew the attention of everybody in the Navy Department to the necessity of greater economy in the steam auxiliaries, and there is no question but what the consumption can be very much reduced. I very much doubt, however, whether it will ever be got below 75 or 80 lb. of water per indicated horse power at the auxiliary.

"As Mr. Woodward points out in his paper, the larger the installation of electric motors, and therefore of generating capacity on board ship, the larger the generators will be, the larger the engines, and therefore the greater economy possible in the main generating plant.

"As to the increase of weight on board ship, that is an important consideration. The electric drive will weigh, all told, between two and a half to three times as much as the steam drive. That, however, is with the present form of steam engine and electric dynamo, such as has been described in this paper. But even with that, I showed in my paper that the saving in economy, and therefore the saving in coal space required, is considerably more than the extra weight added by the additional plant.

"Furthermore, I am firmly convinced that the time is not far off when we shall have a commercial steam turbine which will run, of course, at high speed. For instance, the units on board the *Kearsarge* are 50 kilowatts. The speed there is 40 revolutions per minute. The 50 kilowatt steam turbine will probably run at 600 revolutions and the weight and size of the turbine and generator will be reduced something over half the present steam plant. Vibration will be practically eliminated, that is, the vibration due to reciprocating parts. That means less foundation work, less bracing for foundations, and the application of the steam turbine on board ship for that class of work is almost an ideal one. Doubtless you are all more or less familiar with the experiments with the Parsons turbine in England for driving the propellers on torpedo boats. But there are other forms of turbines, some of which are being developed in this country, and while it has not yet been developed in its final, commercial form, the experiments thus far made I think are sufficient to justify the belief that it will be developed as a commercial success in the near future."

George W. Dickie agreed with the former speaker as to the value of the paper, which dealt with things in a formative condition.

"The electric installations on our warships have not yet crystallized themselves into anything that might be called adopted standards. I have had considerable experience in regard to this," he said, "because every

little while, from the Bureau of Equipment, there comes out a set of standard blue prints, and in a little while another set of blue prints comes out that is also standard. A year ago we got a standard box and I figured out how many junction boxes we would need for the ships we had under way, and I put in the ship 3,000 junction boxes in accordance with this standard. I think about two months ago we got another standard junction box, and we had made 2,800 of the old standard. So I had to get down on my knees to the Bureau to use the old standard for a little while until we worked out the 3,000. I think the new standard is considerably lighter. I lost 4 1-2 lb., I think, in each box, so that this simply illustrates what we are doing in electric matters.

"I am glad that some of the remarks made by Mr. Woodward are not in this paper. For instance, he suggests that enclosed motors should be tested with a salt water hose on them. I hope that does not become standard, because it is sometimes awkward to do that sort of thing. The other day an inspector suggested that an enclosed dynamo should be lowered down ten feet under water and remain there twelve hours and then be run for six hours thereafter. That was worse. (Laughter.) It has not been done. But if you remember, in 1893, I advocated a single system of some kind for power transmission on board ship. I then advocated a hydraulic system of power transmission and proposed to operate rotating machinery by water turbines. Since then, things have changed and the electrical transmission seems to be the coming transmission on board ship. In a paper I had read two years ago before the Society of Mechanical Engineers in this room, I went over the advantages and disadvantages of the various types of transmission on board ship and then intimated that I thought that we were drifting into electric transmission. But whatever goes on board ship I still maintain that one method of transmitting power should be adopted. If an electric motor can be relied on to work a boat crane it can be relied on to work a winch; it can also be relied on for a steering gear and for a windlass. I have just sent in to the Construction Department an electric windlass for one of the ships. I firmly believe that we have come to the time when we can say that no steampipe should be carried outside of the engine and boiler room enclosures except in the dynamo room, wherever that is placed, whether it is forward of the heated compartments or aft, as one of the speakers has stated it should be. I believe that within the next six or eight months we will probably be able to talk more definitely in regard to this subject.

"On the *Wisconsin*, as probably a number here present are aware, we have adopted a somewhat different method of control for the turrets than that described in this paper. We abandoned the one gear for operating the turrets, operate each side as entirely independent of the other and control by hydraulic gear. It will be interesting to find out, which we will do very soon, as to the advantages of this compared with the method of control adopted on the *Kearsarge* and *Kentucky*. The advantage of adopting a control outside of the generator and wire system is that it is not necessary in that case to run special generators for the purpose of operating these turrets, which must be done with the method of control adopted on the *Kearsarge* and *Kentucky*. I think that that will be important, especially when going to quarters and operating these turrets, as they must be operated daily, in order to keep them in good condition.

"There are a great many points in this paper that one could talk about if one had the knowledge to do so. In fact, the paper enters into subjects for which we have very little data as yet to direct us as to what we should do. I think that the time may come when we can operate generators by direct steam turbines as has been suggested; but that time has not come just yet.

"We have been making balance engines that have given very good satisfaction, and in regard to economy I might state here that the generating sets for the *Wisconsin* on twelve hour tests gave the kilowatt output for 31.8 pounds of water in the form of steam consumed, which goes to show that there are great possibilities in regard to economy. However, comparisons have been made in regard to economy of an electric system where the prime movers in the electric device were much more economical engines than those that they were compared with. Making all auxiliaries simple engines of the most wasteful kind I think has done a great deal to bring about other systems of power transmission on board ship. I have invariably advocated the most economical engines for auxiliary purposes because they run oftener and, perhaps, burn more coal in the aggregate than the main engines of the ship. We have two battleships that we have been noting lately where the daily consumption for auxiliaries in one case was 8 1-2 tons and in another case, a similar ship with the same number of auxiliaries, 17 tons. So that the kind of auxiliary is a very important factor to take into account when comparing systems of operation. Apart from the system of operation I think that the steam pipes, outside of the engine and boiler room enclosure, are something that should be avoided as far as possible. They generate heat and the continual heating and cooling of them causes trouble with the joints. Perhaps there is more trouble with leaky joints with steam pipes, outside the engine and boiler room enclosure, than there is with the main pipe inside. I think that any engineer who has been at sea would bear me out in that statement."

F. L. DuBosque believed that the reference to economy made by Mr. Greene in discussion was open to criticism. If the economy predicted by that member could be accomplished no doubt all auxiliaries in vessels would be driven by electricity. It could be readily conceived that a fan driven by electricity would be very economical, as the fan would only take the power in proportion to the air expelled. But could a circulating pump, for example, be so successfully driven electrically? It had been his belief that the electric motors would have to be run at constant speed, and to throttle this by the use of rheostats would be very wasteful. He quoted some of the figures already discussed and calculated that by the use of the electric drive and the interposition of rheostats he would get a consumption of 80 lb. of water per horse power at the auxiliary.

S. Dana Green said the speaker had apparently mis-

understood some of the power statements, and went on to show that the figure given by Mr. Dickie—31.8 lb. of water per kilowatt at the generator—would, after allowing for line and motor losses, give a consumption of 40 lb. per I.H.P. at the auxiliary. The rate of 75 to 80 lb. per I.H.P. for steam auxiliaries was understood by the speaker to apply to the most improved form of compound engines, working under the maker's guarantee. As to the ability of electric motors to operate efficiently at different speeds he referred to the electric street and L-road cars, in which cases the speeds ranged from zero to 40 miles an hour. There were many ways of regulating the speed of an electric motor aside from the wasteful method of introducing dead resistance—by suitably winding the motor.

Naval Constructor J. J. Woodward, in responding, said the importance of the proper instruction of the personnel in the use of electrical apparatus, whether three or two-wire systems were adopted, was recognized. In the case of the *Kentucky* and *Kearsarge*, voluminous instructions had been prepared for the use of the officers and men. As to the distribution boards located in different parts of the ship, these boards were adopted through force of circumstances—to avoid carrying back all circuits to the dynamo room and the consequent multiplication and complication of wires, etc. There was really nothing novel in their adoption so far as the transmission of power was concerned. As to the equipment of the foreign ships with electrical apparatus the speaker believed that had the plants on the *Kearsarge* and *Kentucky* been advanced to their present stage of completion when those installations had been begun the foreign officials would have recognized the advantages in the reduction of the amount of wiring. Answering the criticism of Captain Randle, he said the protection of the electric plant by armor had to be considered. In the case of the *Kentucky* and *Kearsarge*, the solution was not ideal, but the conditions of habitability in the dynamo room were excellent. Fans capable of handling the entire volume of air in the dynamo room in every forty-five seconds had been provided, and where the fan capacity was properly proportioned the variable currents of air referred to had less influence, probably, than where natural ventilation was relied upon. He recalled a remark of a French naval constructor made during his student days abroad, who told him to always mark his plans with red arrows to show where the air supply went and blue arrows to show where the exhaust came from, and to remember that in practice the air would not go that way at all. He was unable to reply to questions regarding efficiency as no tests had yet been made. The matter of "external details" was extremely important—making the various parts that require to be moved in service sufficiently robust to stand the severe conditions of ship work. Apparatus that might look amply big and strong in the shops had a fashion of shrinking up wonderfully when placed in an exposed position on the ship. There seemed also to be a marked tendency for all small iron and steel parts to rust where one might suppose this would not occur.

INCREASING COMPLICATIONS IN WARSHIPS AND HOW SIMPLER ARRANGEMENTS MIGHT BE ADOPTED.

BY GEORGE W. DICKIE.

This paper is a strong plea for the simplification of the interior fittings and equipment of the modern warship, the present tendency being in quite the contrary direction. In opening, the author states, that "the increasing complication and multiplying diversity of functions sought to be reached by mechanical contrivances has become a positive dread to the officer who is held responsible for it all operating in the proper way." The author attributes the complications to two causes: Uncontrolled growth of new devices, additional to existing devices, causing multiplication of apparatus "for doing one thing," and the divided system of control, making a homogeneous design and the proper consideration of the interrelation of functions impossible. As a step towards simplification the author proposes the construction of a tunnel or passage, extending from the chain lockers forward to the steering room aft, to be located on the center line of the ship immediately under the protective deck. This would be the "spinal cord" of the ship, and from this he proposes to "deliver to every compartment of the ship that needed it, by lateral branches only, light, heat, power for auxiliaries, air, and orders of every description." This idea is treated as to its main features only and in relation to the battleship as distinguished from smaller vessels. The passage would be 4 ft. wide and 11 ft. high, the floor making the horizontal stiffening necessary for the center line bulkhead, which would be of the usual construction and extend from the inner bottom to the floor of the proposed passage. Referring to a cross (fire room) section through the battleship *Ohio*, accompanying the paper, which shows the proposed passage in place between two cylindrical return-tube boilers, the author presents some arguments in favor of the fire-tube as against the water-tube boiler. These do not, however, refer to the installation of one type or the other from a structural point of view, but from that of operation. Returning to the subject of the paper, extended references are made to the existing drainage and fire service systems on board our warships. The former he traces from the hand pump of early times, through the period of engine driven bilge pumps, to the method of independent pumps of to-day, none of which took the place of the preceding system, but rather added to the growing complication. Nowadays numerous compartments in the double bottom and elsewhere, coupled with the manifold system in use, occasioned a perfect network of piping—forty-seven drainage pipes were recently counted in the forward end of the engine room of a battleship. The author proposes to abolish all hand pumps, manifolds, emergency connections, combined bilge and fire pumps and such. For these he would substitute two main drainage pipes running the length of the ship, one on each side of the center line bulkhead and just above the stiffener brackets. All suction connections would be made direct to these pipes, and the main pipes so connected that either could take care of the entire drainage of the ship. The controlling valves would have stems passing up into the central working passage,

where would also be fitted sets of vertical single-lift jack-head pumps operated by gearing, the power being in the form of 10 horse power electric motors. The discharges would, preferably, pass up through the berth deck and then overboard above the water line. The pumps would be 12 in. dia., 24 in. stroke, three to a set, and six sets in all—total capacity of system 1,500 tons per hour. One set of pumps would be kept in motion continuously to produce a vacuum in the drainage pipes. The author next pays his respects to the fire service as now installed and proposes, instead, that two large salt water compound pumps be fitted in the pump room between the engine and boiler room. One pump would be always in operation, furnishing pressure for engine room service, distillers, coolers in ice machines, sanitary purposes, flooding magazines, and for washing decks. In case of fire the pump would be run high pressure in both cylinders and would maintain a water pressure of 120 lb. in the mains. There would be two mains running the entire length inside the central passage, and stand pipe connections would be run up where required. It is also proposed to place two feed pumps in the pump room of economical type and from these run two feed mains, each connected independently to each boiler. A constant pressure would be maintained in the feed main, slightly higher than boiler pressure, to ensure reliable feed. In the pump room also there would be two small fresh water pumps connected with the water tanks and with a main in the central passage with necessary branches. Interior ventilation would be provided for by electrically driven fans connected with a main air duct in the roof of the central passage. From this branches would carry fresh and, if need be, heated air to the living spaces, thus getting rid of the present steam heating systems. For cooling the magazines a small electric motor-driven air compressor would be fitted supplying dense air to the magazines. Light and power transmission by electric current is referred to, the engines and boilers being located forward of the forward boiler room, and the feeders arranged to be carried fore and aft in the central passage. Means of interior communication are next discussed, the suggestion being made to increase the inside diameter of the armored tube leading down from the conning tower, so that a man could go down for inspection and repair work. The various signaling connections, mechanical and electrical, would be carried the length of the ship inside the central passageway, branching out at such compartments as needed in. Lastly the author treats of water-tight doors with practically these recommendations: Careful design to reduce number of doors; all doors except coal bunker doors to be hinged and locked by one lever; abandonment of "complicated mechanism" for closing doors from distant parts of the ship; additional stiffness in door frames. All doors from the central passage would open into the adjoining compartments and be fitted with rubber joint so that if a compartment was flooded the door would remain tight. Brief reference is made to the central passage system in certain British naval vessels which, however, is an ammunition passage rather than a subway for purposes of distribution of power, light, etc. The paper contemplates the extensive use of the electric drive and the confinement of the use of steam to the machinery spaces proper.

The reading of the paper was accompanied by running comment by the author, in the course of which he said: "Regarding ventilation, experiments at the Union Iron Works had shown the great advantages of a pressure system over a vacuum system chiefly on the grounds of habitability. In practice, too, the plan of blowing in warm air in winter and cold air in summer had been tried in the saloons of a ferryboat carrying 3,000 passengers, and had been entirely successful. This was a question which in relation to the cooling of the magazines on the naval vessels called for intelligent discussion.

DISCUSSION.

F. B. King opened the discussion by calling attention to the construction of the monitor. John Ericsson, he said, had built and launched this vessel with her steam machinery complete in 100 days; and he drew a comparison between the simplicity and celerity of construction of the monitor and the complications and delays in the construction of naval vessels to-day. He proposed a continuity of naval policy of uniformity and standardization. Vessels to be confined to the fewest possible classes, and simplified in design; a unit system of construction control adopted, so that as far as possible ordnance, machinery and hull could be made up of numbers of identical parts; only Government designs to be used, and these to be complete in every detail, leaving no room for inspection disputes or local changes; bonus to be offered for fast construction, and steps taken to train up a class of men who could build a warship in the minimum of time.

Naval Constructor W. J. Baxter said he had read a paper on the subject before the Naval Institute several years ago—it didn't have much effect. There were two additional reasons for the lack of simplicity. One was the demand made upon shipbuilders by the people who go to sea. As to drainage pipes, however, the tendency was to get rid of these, and in vessels that he had refitted he was able, by proper representations, to get rid of the hand pumps, and thus of about 50 per cent of the drainage pipes. The other reason was that people who designed ships paid too much attention to possibilities and provided too many appliances (gewgaws), which were either not understood by those supposed to use them or not kept in a high state of efficiency.

Naval Constructor Francis T. Bowles was much interested in the simplification of design of warships and resultant cheapening of cost—matters to which no attention were being given. "We are running riot in the expense of our vessels and in the expense of maintaining them," he said. Any suggestion of emergency shipbuilding, however, was regrettable, and as to the monitor, she was "noble in conception, but horrible in detail." He did not wish to underrate the genius of Ericsson, but in all his work Ericsson went a long way round to reach the desired result, and the speaker knew a very distinguished man who said he would not permit Ericsson to design a wheelbarrow for him. With reference to the central passage idea, this had been worked out probably more extensively in the *Texas* than in any other ship of the Navy, and had proved a valuable feature.

Barnum W. Cowles believed in simplification, and to that end had worked out his plan for closing water-

tight doors. On the *Maine* the pneumatic system had been adopted and a central station used for the air compressor run by electric power. The machinery would only take up 30 in. by 40 in. floor space, and would weigh inside 1,000 pounds.

Naval Constructor W. L. Capps approved of the scheme proposed in the paper in general, but believed that the main question was the human one. Until everyone thought alike there could never be complete uniformity.

Naval Constructor John G. Tawresey said: "It is not that we have not thought of these things, but it takes something more than thinking to carry them out. I would not attempt to say which are the most important features of the paper, but one or two of them appealed to me more than the others, because I did try to carry out some of them, with little success. The chief obstacle I found was the contractor. The contractor was very anxious to go right ahead with the work and have no change made in the plan. The particular feature is transporting the coal fore and aft above the deck and in dropping it into the lower bunkers, and then through the lower bunkers into the fire room. I did not see why the coal stowed above the protective deck should not be delivered at the mouth of the furnace and the coal in the lower bunker kept in reserve. I appreciate, too, what is said about ventilating and supplying air to the compartments, instead of exhausting it from the compartments. I have been in favor of that for a long time, and have had a great many controversies about it. I think we are gradually working around to that system on all the ships."

George W. Dickie, in responding, said the question of cooling magazines was of hign importance to the Departments of Construction, Engineering and Ordnance.

Cecil H. Peabody doubted if the plan of cooling suggested by Mr. Dickie would work.

George W. Dickie referred to a test made in the magazines of the *Wisconsin*. These were heated up artificially to 115 deg. and then a 3-4 in. compressed air pipe was run in, with the result that in the first four minutes there was a reduction of 8 deg., and in twenty-eight minutes the temperature had dropped to 69 degrees. The quantity of air used was not recorded. He had had experience with very hot workings in mines—blind drifts where rock drills were operated by compressed air—and it was almost impossible to prevent the miners from cutting holes in the compressed air pipes and thus cooling the drift. "There is no doubt," he said, "that by liberating air under pressure at the floor of the magazine and letting the magazine fill with cool air—just as you fill a tank with water—the warm air will escape at the top, and this will accomplish the purpose. The idea at present is to use ice making machines and put pipes on the sides of the magazines; but I think it will be found that these pipes may get pretty cold, and yet little or no reduction of temperature in the magazine result." As to the operation of bulkhead doors referred to by Mr. Cowles, the Union Iron Works have in operation a hydraulic system for opening doors in the yard. The storekeeper, for instance, sat at his desk, and by moving a little valve opened or shut a door 50 ft. by 25 ft. in dimensions. In the case of the hydraulic system fitted in the *Monterey*, the doors were operated by hand apparently because it was too much trouble to start the pumps to operate them by power.

BEAM FORMULÆ APPLIED TO A VERTICALLY STIFFENED BULKHEAD, WITH SOME RESULTS.

BY H. F. NORTON.

This is a purely scientific discussion of the subject described in the title and is supplementary to the paper entitled, "Test of the Strength of a Longitudinal Bulkhead Separating two Engine Rooms," read by Naval Constructor J. J. Woodward, at the previous meeting of the Society. The tests were applied to a bulkhead of the battleship *Illinois*, under construction at Newport News. After referring to that paper Mr. Norton says: "In order that a more intelligent idea of the reasons for the action of the bulkhead test might be obtained, a mathematical analysis of vertically stiffened bulkheads under water pressure was worked out." In this paper the process followed and the results obtained are set forth. In opening, the author states his premises thus: "Unless the bulkhead is so small and the deflection so large that the plating acts as a tie in some direction, it is practically relied upon only as a water-tight diaphragm, the rigidity of the bulkhead against pressure depending almost entirely upon the stiffeners, the plating entering as a factor only so far as it may be considered to form a part of the stiffener. In the case under consideration these stiffeners are vertical, spaced equally, and bracketed at the heads and heels. We then assume that the stiffeners must bear the whole burden, that each takes its equal share, and that the load upon each consists of the water pressure upon a strip of plating extending an equal distance on each side of the stiffener. In supporting this load we assume that the stiffener acts as a beam, conforming to the laws of flexure, and that the bracketed stiffeners act as beams fixed at the ends. Since the bulkhead is vertical the water pressure upon any point will depend upon the distance of that point below the surface." Then follows the mathematical treatment of the subject as adopted by the author. In the course of this it is shown that the results reached by computation vary from those obtained by observation to a degree that might reasonably be expected, and which shows that our present knowledge of the controlling conditions does not permit of exact theoretical determinations. The variation, however, was not irregular, but exhibited well-sustained relation to the actual measured deflections, and more clearly showed the necessity for a further accumulation of experimental data. In concluding his paper, the author disclaims any intention to "build up any new theory on this one case," but simply offers the results as a contribution to the fund of knowledge out of which the satisfactory treatment of bulkheads may be evolved. In the form of an appendix the mathematical processes of reasoning are given in detail in specific cases, and a chart with graphic treatment is included.

No discussion followed the reading of this paper, which was presented by the author.

NOTES ON SHEATHING THE U. S. S. CHESAPEAKE.

BY NAVAL CONSTRUCTOR LLOYD BANKSON, U.S.N.

This is a practical description of the work done on the new Naval Academy practice ship *Chesapeake*, the first American naval steel hull vessel to be sheathed. She is a ship-rigged sailing vessel, in dimensions: Length, on water line, 175 ft.; beam, extreme, 37 ft.; draft, mean, 16 ft. 6 in.; displacement, 1,190 tons. The ship was designed by the Bureau of Construction and Repair and built by the Bath Iron Works. Specifications for sheathing called for a teak keel, white oak false keel, and Georgia pine planking to extend from the keel to about 26 in. above the water line amidships. The planking to be worked in one thickness, 4 in. thick, reduced to 3 1-2 in. for the two top strakes and at the ends; and to be 9 in. wide amidships and on the sides about 8 in., tapering forward and aft to make fair work. For fastening 3-4 in. naval brass screw bolts were specified, these to be screwed through the plating between frames with brass nuts and iron washers on the inside. At commencement of the work it was found the planking had to be steamed to make a good job. It was not practicable to put the plank in place, mark the holes from the inside, then take it down and bore the holes square with the inside surface, though the specifications called for the drilling of the plating first. Accordingly the holes were first bored in the planking when it was in place, then the plating was drilled and tapped, and lastly the plank holes were counterbored to take the heads of the bolts. The bolts were put in with a hemp grommet under the head and with red lead putty, the bolt being well hove up by pneumatic tool before the nut was put on inside. When the nut was jammed down centerpunch marks were used on nut and bolt end to show they were tight. Before fitting the plank the hull was tested for watertightness and all leaks stopped. The skin plating had been previously pickled and, after cleaning, a coat of red and white lead was laid on. The plating was fitted in the usual manner with inside and outside strakes. After sheathing the planks were bored at intervals and lead putty was forced in at pressure to fill up all interstices between the planks and hull plating. Care was taken to have the planking beveled to leave a good seam for caulking and avoid the use of the reeming iron. After caulking the seams were payed with hot pitch. Whenever possible the butts of planking were located between frames. Difficulty in making watertight work by caulking was met with between the stem and stern post castings and the outside plating. Where bolts fetched up against a bulkhead in out-of-the-way places, before they were flush with the sheathing, they were withdrawn and shorter bolts substituted. In these cases no nuts were employed. The bolts used were made of: Copper, 62 parts; Silesian zinc, 37 parts; tin, 1 part, and had a tensile strength of about 47,000 lb. A list of weights gives totals of: Fastenings, 11,883 lb.; sheathing and filling, 162,313 lb. The approximate area of sheathed surface is 7,583 sq. ft., and weight of materials per square foot, 27 lb.—in both cases keels are omitted. The sheathing is bound at the top by an angle 3 in. by 3 in. by 7 lb., weighing 2,345 lb. The time consumed in the work, exclusive of Sundays and holidays, was: Planking, 40 days; caulking, 26 days; pumping putty, 17 days.

There was no discussion on this paper.

Third Technical Session.

On Friday morning there was a considerable attendance of members in the hall when the Chairman, Rear-Admiral Bunce, U.S.N., called the meeting to order at 10.30 o'clock, and announced the reading of the first paper on the programme.

SYSTEM OF WORK IN A GREAT LAKE SHIPYARD.

BY W. I. BABCOCK.

In this paper the author describes with much minuteness the methods employed in the shipyard at South Chicago, Ill., in the construction of the ordinary type of lake freight steamer. The special aim of the management is to economize by the use of methods of duplication in construction and to this the special form of lake steamer readily lends itself. By way of preface the author describes the typical lake steamer and sketches the special requirements of the service. Nearly all modern steel lake vessels are designed to carry only ore, coal, or grain in bulk, and consequently no deck is required over the main deck beams in the cargo holds. The movement of ore and grain is entirely from the upper to the lower lake ports, and of coal in the opposite direction. Competition of modern vessels and necessary slowness in unloading coal often causes the big steamers to return light. Ice limits the season of navigation to seven months and dispatch in ports is a necessity. Cargoes are spouted in and unloaded by machinery on the docks, so no hoisting machinery is carried. Shallowness of connecting channels between lakes calls for vessels with plate keel, very flat floor and full model—a large number of frames amidships are thus alike, as many as one-half to two-thirds the total number. When light at dock such vessels float very high out of the water, and to obtain the necessary slope to the spouts the hatches are made as wide as possible athwartships, leaving only stringer enough for strength on each side. The upper deck could be depressed by filling the water bottom, but this would cause loss of time in loading; cargo can be run in faster than water pumped out. The longest and straightest run in open water is across Lake Superior, about 400 miles, and the total voyage is less than 1,000 miles. Fuel is easily had at points in the connecting rivers, and is loaded through fuel hatches in the upper deck by a spout. At lower lake ports the vessel while unloading, is coaled from a lighter, with derrick, alongside. Danger of grounding in channels calls for double bottoms, which are carried straight across on top to protect the bilge to the upper turn. To get sufficient water ballast, and to raise up an ore cargo so as to make the ship easier in a seaway, the tank is made deep—5 ft. to 6 ft. at center line. As a consequence, heavily-stiffened and closely-spaced girders or longitudinals are needed. These are intercostalled between the floors to support them and the bottom plating from grounding strains. The use of channel iron floors for the flat of bottom is general and effects a saving in first cost, and also avoids shearing of rivets and crack-

ing of frames from grounding, as in the ordinary construction. Ore and coal loading docks have the spouts spaced 12 ft. centers and all hatches are spaced 24 ft. centers, fore and aft; and frame spacing is always 24 in., the frames being channels. Hatches are 8 ft. fore and aft and channel web frames or belts are spaced 8 ft. apart; making one belt at each hatch beam, and one in the center between hatches, on which a main deck beam is placed. To suit the spacing of loading spouts as well as to avoid a shaft alley in the cargo hold the machinery is as far aft as possible. Engines near stern post, boilers and bunkers next forward, either in hold, or on a raised deck with cargo space beneath. A vessel built to these trade requirements—S.S. *Mauna Loa*—at the yard has the following characteristics: Length, keel, 430 ft.; over all, 450 ft.; beam, moulded, 50 ft.; depth, moulded, 28 1-2 ft.; water bottom, 5 1-2 ft. deep; engines quadruple expansion, four crank jet condensing, of about 2,500 horse power; boilers, Babcock and Wilcox, marine type, working at 250 lb. pressure; light load displacement, 3,200 tons; carrying capacity, 6,816 gross tons (iron ore) on 18 ft. 3 in. draft; water ballast capacity, 2,900 tons; speed loaded, 12 statute miles; speed light, 14 miles. Details of the yard and the methods employed in the construction of this and similar vessels are then given. Advantage is taken of the form of the ship to order a large quantity of material—plates and shapes—in duplicate pieces from the mid section as laid on the mould loft floor. When the lines are faired and body plans completed on the floor the remainder of the material is ordered in the usual manner. Extensive use is made of wooden moulds to get out material, so that sufficient plates and shapes for almost the entire water bottom for the straight midship body, and for a considerable length forward and aft of this, can be gotten out rapidly from a few moulds, before the keel is laid. All pine moulds for butt joints are provided with adjustable lignum vitæ strips at the ends, so that swelling or shrinking of the softer wood can be compensated for. For lap joints this is, of course, unnecessary. Points are given concerning the use of moulds, the laying down of the ship (broadside launch) the assembling of the material, and construction of the hull, and in conclusion the author discusses the question of how far the mould system may be carried with economy. After an experience with thirty vessels built under this system he is of the opinion that it "is the cheapest known, and can be applied to a large extent with great advantage in any yard where large ships are built."

DISCUSSION.

Naval Constructor William J. Baxter opened the discussion by remarking that those who had to do with the building of warships endeavored to get as many wrinkles from the Great Lakes as possible. He considered the paper very valuable as an exposition of an American method of building ships.

George W. Dickie said: "It is startling to the ship builder who does not know practically what methods have been adopted on the Great Lakes to find how simple a thing a ship can be made, if it is so desired. In looking at the midship section of this vessel, the first thing that strikes one is the method of carrying the inner bottom to the side of the ship. This is not the usual method in seagoing vessels, and why it has not been adopted has always been a matter of surprise to us. We have proposed it many a time. Drainage has been considered as an obstacle to the carrying out of this plan. But where a vessel has considerable deadrise which this vessel has not, and the drainage can be brought to the middle of the vessel instead of to the bilges, as is usual in double bottomed vessels, there is no reason why it should not be carried out. It is also a matter of great safety. We had on our dock last month a vessel, the *Matteawan*, that had been ashore in the Straits of Magellan, with her whole bottom practically out. Fortunately for her the absolute penetrating of the plates did not extend beyond the boundary plate of the double bottom. Had it done so the vessel could not possibly have been saved. The bilges were all out of shape, but at no place was the plate actually fractured outside of the line of the double bottom, but here we have a vessel that is safe for a height of practically six feet. Another startling thing to most shipbuilders is the fact that a vessel of 430 ft. in length can have practically 288 ft. from one mould. We never would have expected this. I do not see why it should not prevail in seagoing vessels as well as in lake vessels; but as yet we have not been able to do much in that line. The fact of the engines being close to the stern also permits of this mould system throughout the midship section of the vessel, the frames being all alike. Usually in our practice we have an entirely different method of framing, right in the middle of the ship, under the engines and boilers—more intercostal work, and difficulties that would interfere with the carrying out of the system."

James Dickie, of the Union Iron Works, in a communication, said it was not possible to carry the system as far on the seacoast as on the lakes. In vessels that went on long voyages, for example, it was not possible to put the engines at the stern, for a vessel using from 1,000 to 1,500 tons of coal on a voyage would be very much down by the stern when loading, and very much down by the head on arrival, unless half of the coal was stowed at the forward end. This would mean a conveyor for carrying the coal aft, and then the extra cost would offset the advantage. Oil vessels were built that way, but the cargo carried made the problem of trimming a simple one. Further, it was not advisable to build ocean-going vessels with so long a straight body and full ends; and, again, with the engines near amidships enough rise of floor could easily be had to secure proper drainage. In getting out work the San Francisco yard used very much the same system, the difference being that battens and gauges were used wherever possible, and templates instead of moulds. The templates were 1-8 to 3-16 in. thick, and instead of being bored with holes the center punch was driven through them, making very accurate work. On one occasion the yard had built eleven barges from patterns and templates, only one of the barges being put together in the yard. The others were erected at their destination and proved very satisfactory. In the battleship *Ohio*, under construction in the yard, all the keel, all the longitudinals, the armor shelf, and all the interior bulkheads were gotten out, and the vessel put together, using the longitudinals instead

of ribbands for frame spacing and for the bulkheads to regulate the transverse shapes. It was their experience that work laid out gave more accurate results than the method of building a vessel piecemeal.

Richard L. Newman related his experiences with the mould system in lake practice. Two revenue cutters for the Government were built under this system with the exception of the shell plating. With regard to the lake type of ore carrier he believed that the excessive strength of the tank was unnecessary. When these vessels struck the bottom it was usually necessary to dry dock them for repairs, and it would be better to take a little of the weight from the bottom and place it higher up. It was probable that the mould system would be widely adopted, and would become the rule rather than the exception.

George W. Dickie asked the author if it was true as reported, that it was getting to be the practice on the lakes to carry water ballast loose above the double bottom.

"I have proposed it once or twice," he said, "for some of the ships that have too small ballast capacity for the West Coast. You know we have a very difficult route from San Francisco to the Sound, especially in the summer time, and the boats have been knocking themselves to pieces; and I suggested some time ago, instead of building the deep tanks that we have been putting in quite a number of these vessels, where they carry water only by being fitted with a deep tank, that they might just let the water out above the double bottom and carry it where it was wanted."

Mr. Babcock in reply to Mr. Dickie's question, said: "I cannot say that it is a practice that I thoroughly approve of myself. At the same time it is continually done on the lakes, and has been done for a very long while. I think the principal danger is when a boat is pitching in a head sea—that, however, is the only time that water is admitted into the hold, because the only reason for it is to get the wheel down—the ship going up light against the head sea. The danger is that as the bow rises and the stern falls on the wave the rush of water back may carry away the engine bulkhead or the boiler bulkhead. I never heard of that occurring. In fact, with very long ships, ships over 400 ft., a keel which is now common on the lakes, there is less danger in carrying over water in the hold than in the shorter ships. Although the seas are pretty high they are very short on the lakes, and we find that the long ships do not pitch nearly as badly as the short ones, because they extend over too many seas at one time. But it is certainly not at all an uncommon practice to start a manhole cover off so as to allow the water from the water bottom itself to come into the hold. In fact, we did put in in one or two boats, at the request of the owners, a valve that works from the upper deck through the tank top to allow the water from the water bottom to go into the hold—put in simply to save the trouble with a small crew of having to send a man down below. So far as rolling is concerned, the boats are so very stiff that you may say that the free water makes them easier than if they did not have it. I have known also of two or three cases of wooden steamers, small wooden steamers—for none of them are very large—and of course boats that had no double bottom and no water ballast, ordinarily admitting free water into the hold with a system of floating hatch covers on it. The covers float on 3 or 4 ft. of water and keep it from slashing around too much.

"I might say that on the lakes we are not especially bothered by precedent. The people up there have an idea that if anything appeals to them as being a good thing to try, it does not make very much difference whether anybody else has tried it or not; we go ahead and do it. It is possible, for that reason, that the lake ships are considered to be as well fitted for the peculiar conditions which obtain on the lakes as any class of ships in the world. I say that without being accused of egotism, because I did not begin out there; I have only been there a few years now. A good deal of what has been done was there when I went West. I surprised an Englishman very much the other day, a man who was visiting the yard and who seemed to find fault with everything we did. I told him that it did not make any difference to us how they built ships in England; that we built them the way we thought was right for our business."

Col. Edwin A. Stevens called attention to a feature suggested by the paper: "The success of American shipbuilding as a commercial matter rests on the ability to meet competition." Now that builders were placed on as good a footing here as British builders, in the matter of material, the application of those methods that had brought success to the bridge builder in foreign competition, would, with the skill and intelligence of the American mechanic and engineer, bring success. The evolution of a peculiarly American system of building ships—in the same way that America had evolved a system of building bridges—had been best exemplified on the lakes. In looking into the figures of fuel consumption of lake steamers, the speaker had never been able to find any other figures for moving freight by water per ton mile that came anywhere near the lake figures—and he understood those figures were correct.

Mr. Dickie: "I would like to qualify a statement by Mr. Stevens in regard to the corresponding advantage that the American shipbuilder has to the British in regard to material. I think that we labor here under a very great disadvantage on account of the enormous fluctuations in the price of material. I read the other day an article by Mr. Stevens in which he stated that a great iron master here—of course we all know who he was—stated that he was prepared to construct and lay down material in an Atlantic seaboard shipyard at a less price than the same material was delivered in any British shipyard. That was several months ago. That same iron master is charging £18 8s. 6d. for material in New York to-day for ships, while the British shipyards have it at £7 8s. 6d."

OVERHEAD CRANES, STAGING AND RIVETER CARRYING APPLIANCES IN THE SHIPYARD.

BY JAMES DICKIE.

This paper is devoted chiefly to a description of the methods used at the slips in the Union Iron Works, San Francisco. Brief references are also made, at the commencement, to the manner in which the problem of handling the structural material has been met in various yards at home and abroad. In opening the author calls attention to the increasing need of "overhead" handling appliances, due to the extended use of power riveting.

Other matters to be considered are the staging required during the process of construction and the necessity of keeping the upper works fair during the earlier stages. These matters form a large portion of the cost of construction of a large merchant or naval vessel, and the problem of a structure to facilitate the performance of the four functions mentioned is thus presented. Prior to 1884 the only means of hoisting material was the derrick pole with swinging gaff. Other and more recent methods are: (1) The cantilever traveling crane, such as is used at Newport News. This, however, only hoists material, and provides but one crane for two ships. In criticism of this method the author says the time of hoisting and traveling is comparatively brief, 95 seconds being the average; while from 7 to 12 minutes were needed to secure a member in place before the crane could let go. (2) The overhead crane or gantry, traveling all over the vessel with rails on the ground on each side—much used on the lakes. There broadside launching is used, and so two such cranes can be put to work and moved beyond the ends when launching—but they can only hoist. (3) The gantry at Belfast used for the construction of the *Oceanic*, performing the functions of hoisting and carrying riveters only. It appears to be limited in operation, covering not more than 120 to 150 ft. of the vessel's length at one time, and being so large and heavy, must be slow in motion. (4) The framework which covers the entire vessel while building, with examples at Swan and Hunter's English yard and at the Union Iron Works, and which performs the four functions already referred to. At the 'Frisco yard there are four such stuctures. Three are 300 ft. in length and one 408 ft. long, all of varying dimensions in width and height —the largest 85 ft. wide and 78 ft. high. They are all built of wood and are similar in construction. At each end there is a 50 ft. swinging crane, giving an additional reach of about 100 ft. in length of vessel which could be served. Overhead electric cranes of 5 tons' lifting capacity are fitted in the largest framework, each covering one-half the beam of the vessel. The apex of the roof is off center sufficiently to permit one of these cranes to handle material on the center line of the ship. For plating under the bottom and under the counter, hoisting is done by a wire rope rove through the plate and the corresponding hole in the frame and toggled below the plate, and in this way the plate is drawn up close, ready for riveting. All the posts of the structure are spaced 12 ft. centers and the construction lends itself readily to staging, the plank for this purpose being 2 in. by 12 in. by 26 ft., which is strong enough and easy to handle. In the new slips it is proposed to fit up light cranes of 8 in. T-bulb beam, each supported by two suspension rods. These will be placed on opposite posts and fitted with trolleys from which there will be hung a cross beam, and on this the riveter will be suspended from a trolley. The cross beam can be raised or lowered as required. These cranes will each have a reach of 32 ft., so that there will be sufficient space between the inner ends for the overhead cranes to carry material the length of the ship. Thus, hoisting and riveting can go on simultaneously. With this structure no side shores are used above the bilge, and for fairing the upper works turnbuckles are used reaching from the sides of the ship to the structure. These can be readily lengthened or shortened by men on the upper staging. The riveters used are toggle-jointed air machines that drive 7-8 in. rivets with 30 in. gap, and weigh 1,400 lb.; also percussion air machines, with 4 ft. or 6 ft. gap and weighing only 250 lb. Several scale drawings and photographs accompany the paper.

In the absence of the author the paper was read by the Secretary.

DISCUSSION.

Henry G. Morse referred to the successful operation of the gantry crane (one crane for two ships) at Newport News and at Cramps. The Union Iron Works used two cranes to one ship, which plan, though possibly best for a very large ship, might not be so for an intermediate size. He believed the best plan would be to have one crane for a small ship, two for the next larger size, say a large coastwise steamer, and three cranes for ships of the largest size—liners. Two cranes on a very small vessel meant an extra motorman and gang for handling material. At Harlan & Hollingsworth he had put in a single crane for one ship and they had to work overtime to get the material on board in time for work. This was chiefly because the plates were laid out before the frames were up—400 or 500 plates laid out by templet were ready to be raised into position.

John Platt said that Harland & Wolff put in their crane only for very big and very long ships. This gantry was not primarily for handling material—it was a riveting gantry more than anything else. Harland & Wolff endeavored to handle material on the ground, on cars, as much as possible. There were four jib cranes attached to the gantry, covering the portion of the ship under the gantry, and these were operated hydraulically and moved the riveters about. The riveters were very heavy, having a 6 ft. 6 in. gap and applying 40 tons pressure on the rivet. The rivets used in the *Oceanic* were 1 1-4 in. dia., and as there were butt straps and cup head rivets all above the water, heavy rivetting was needed. This was the first time these heavy rivets were closed by hydraulic power. When the ordinary store rivets were tried first it was found that they were 1-2 in. too short—with the machine exerting 40 tons pressure on the rivet an additional 1-2 in. in length was required. The big gantry moved slowly but was readily handled by hydraulic engines, and speed in locomotion was not called for.

Mr. Morris in criticism said the Harland & Wolff crane had only a range of 150 ft., and so with a ship 700 ft. long it could only reach a small portion of the ship at one time. With seven such machines he believed the ship could have been built in one-third less time, especially if the plates were laid off before hand.

Mr. Platt replied that the *Oceanic* was built in the least possible time, conditions considered, and Harland & Wolff were so well satisfied with the gantry that they had ordered three more of similar size to go over new slipways.

George W. Dickie believed that everyone engaged in shipbuilding preferred his own tools which were evolved to suit his special wants—local questions of labor, etc., entered into the matter largely. In the last slip finished at the Union Iron Works provision was made for two cranes on each side—four cranes to a ship. In construc-

tion these cranes were very cheap, four could probably be put in operation for the cost of one large single crane, such as is used elsewhere for two ships. The staging possessed great advantages in erection.

DESIGNS FOR DENVER CLASS SHEATHED PROTECTED CRUISERS.

BY CHIEF CONSTRUCTOR PHILIP HICHBORN, U. S. N.

This paper describes the chief characteristics of the proposed new cruisers, designs for which were prepared during the past year. In authorizing the construction of these vessels Congress also provided for three battleships and three armored cruisers, with the further provision, however, that no contracts for the hulls were to be let until contracts had been made for the necessary armor plate. The price of armor was at the same time limited to $300 a ton, and as no bidders responded at that figure the designs for these two classes of ships were delayed, and are thus not presented with this paper. The question of armor not entering into the construction of the small cruisers, the plans were completed and bids entertained. The proposed vessels are about the size of the *Raleigh* and *Cincinnati*, which, though classed as 19-knot boats, were never able to maintain a rate of speed even approximating to this. The *Raleigh* when with Dewey's squadron could only steam with difficulty at the rate of 9 knots, using three-fifths boiler power. Coal consumption was also limited. In the new vessels no attempt has been made to secure "fancy" results, but they have been designed for hard service, having in view especially the offensive and defensive qualities, suitable speed, durability, habitability, and the independence of coaling and repair stations as far as possible. A displacement of 3,200 tons and a speed of 16 1-2 knots was decided upon. The bunker supply is 700 tons, giving a full speed radius of action of 2,500 knots, and economical speed radius of 7,000 knots—or a continuous trip from San Francisco to Manila. The construction is unusually heavy. There will be a 1-2 in. protective deck, but no ram, and the vessels will be sheathed and coppered. All woodwork will be fire-proofed, and corrugated metal freely used. Liberal allowance has been made for machinery weights, which will be 10 per cent heavier than in the *Raleigh* or *Detroit* classes. The engines will be vertical inverted, triple expansion, of 4,500 I.H.P., with cylinders 18 in., 29 in., and two 35 1-2 in. by 30 in. stroke, to work up to 172 revolutions. Water tube boilers (6) will have about 300 sq. ft. grate surface and 13,000 sq. ft. heating surface, and will carry a working pressure of 275 lb. Auxiliaries and other apparatus will include distilling plant, ice machine, refrigerators, electric ammunition hoists, winches and blowers, searchlights and signalling apparatus. The electric generating plant will consist of four units, each of 300 amperes 80 volt capacity. Armament will include ten 5-in. guns of 50 calibers length, and eight 6-pounders, two 1-pounders, four automatic guns and one field gun. Nickel steel protection for the guns' crews will be provided. Ammunition will be carried in considerable quantities—250 rounds for each 5-in. gun and 500 rounds for each 6-pounder. Smokeless powder will likely be used for all guns. Much care has been given the berthing of the crew, the ship's complement being 263, including 27 marines. Additional accommodation for a total of 450 men can readily be improvised in the available space, and the vessels will thus be useful in transporting relief crews to foreign stations as need be. The author alludes to comparisons drown by critics between the foreign-built cruiser *New Orleans* and the ships of the *Denver* class, and shows that the latter excel in the requirements of practical service. "I do not pretend to criticise the design or construction of the *New Orleans*," he says, "but she is essentially a 'show' vessel, cleverly designed to that end, but no such design as would be found emanating from the British Admiralty or our Navy Department." Or, in other words, "she was designed purely for speed and the heaviest battery the law would allow." Plans of the new vessels accompany the paper.

In the absence of Constructor-in-Chief Philip Hichborn, U. S. N., the paper was read by Arthur Cassidy, of the Bureau of Construction and Repair.

DISCUSSION.

ENGINEER-IN-CHIEF GEORGE W. MELVILLE, U. S. N., in a communication read by Mr. McFarland, said that in reading over the paper on the *Denver* class he thought that the Chief Constructor need not have felt called on to defend the design, inasmuch as it was decided upon only after very careful consideration by the Board of Construction. He was sure the expert officials of the Department knew the needs of the service, and how to fill them, better than the newspaper critics. He noticed with regret some statements in the paper concerning the *Cincinnati* and *Raleigh* which would have a tendency to create an erroneous impression about those vessels. These statements quoted by the writer were to the effect that, "owing to certain well-known conditions," the cruisers were never able to maintain a speed even approximating to the rated 19 knots for any length of time, and also that the *Raleigh* when with Admiral Dewey's squadron could only with difficulty steam 9 knots.

"I am sure that he (the Chief Constructor) could not have intended to give other than a correct impression, and can only attribute these statements to the fact that he was not in possession of full information," continued the Engineer-in-Chief. "As I am enabled to give the actual facts from the logs of these vessels, I shall show that the *Raleigh* has on a number of occasions made an excellent record; and, further, that the general statement with respect to the speed of 9 knots while with Admiral Dewey's squadron, and which as it stands might be supposed to refer to the home cruise, is entirely erroneous. First, however, let me say that the *Cincinnati* and *Raleigh* were designed at a time when there was a perfect craze for high speeds in all classes of vessels. The statement had been dinned in our ears so long that we must get at least as good results from every ship as were obtained from foreign ships, and must, if possible, do better; that our designers were really working, as one might say, under the lash. Just before these designs were prepared the British Admiralty had gotten out designs for what were known as the 'M class of cruisers,' which had exactly the characteristics of the *Cincinnati* and *Raleigh*—large power in a small hull. The history of those ships has been very much the same as the history of ours, in that they have not been a brilliant success, and that the English, as well as our-

selves, have realized that it is unreasonable to sacrifice too much to speed in a small cruiser."

Owing to the fact that the *Cincinnati* and *Raleigh* were built in the Navy Yards there were no trial trips under the usual conditions of acceptance from private builders, and, although it had been the intention to have such trials, the need for the vessels caused them to be put into active service as soon as they were completed. The *Raleigh*, after having been in commission about two years, and without any special preparation, was given a four-hour trial March 25, 1896, with her regular crew. The wind and other conditions on this occasion were unfavorable and trial took place in comparatively shallow water, ranging during the first two hours from 14 to 17 fathoms, and at no time exceeding 25 fathoms. Under these circumstances the best results as to speed could scarcely be expected; but, nevertheless, on a displacement of 3,574 tons (about 400 tons more than design) the average speed obtained was 18.64 knots, while during two hours of the trial the average was 19.27 knots. Captain Miller, the commanding officer, had reported at the close of the trial that, with the exception of the middle fire-room blower, everything was in good working condition. Very few men in the ship had ever had any experience in firing with forced draft, and the coal was the run of the mine.

As to the statement that "the *Raleigh* when with Dewey's squadron was only able to steam with difficulty at a speed of 9 knots, using three-fifths of the boiler power," it is to be remembered that the *Raleigh* had not been docked for about seven months previous to the battle of Manila, and that, in consequence, her bottom was very foul and the speed was thereby necessarily materially reduced.

As the *Raleigh* had recently returned from Manila, it was of interest to quote from the official records as to the speed on the return trip under the fractional (three-fifths) boiler power alluded to. On the trip from Bombay to Aden, a distance of 1,642 knots, and with slightly less boiler power in use than during the Manila fight, under natural draft in a tropical climate, and with no special effort to make time, an average speed of 13.14 knots was maintained. After arrival at Aden there remained sufficient coal for 928 knots, or an endurance of 2,570 knots at the speed mentioned. Leaving Aden an average hourly speed of 12.78 knots was recorded for the next 1,300 miles, with the same boiler power in use. These runs were not cited as "fancy figures," but simply as indicating what the ship has readily done under ordinary conditions.

An examination of the same log-book showed the fact that ordinarily, and for economy in coal consumption, the *Raleigh's* speed in cruising did not, as a rule, exceed 12 knots, and generally was below that figure. Many instances, however, were recorded where the speed was materially greater, and on one occason (October 12-13, 1896), during a trip between Hampton Roads and Smithport, N. C., when speed was apparently important, an hourly average of 15.9 knots was maintained for sixteen hours under natural draft with about five-sixths boiler power.

He was glad to indorse the remarks of the Chief Constructor with respect to the importance of adequate coal supply, and also of proper internal arrangements. It was well known that in these respects both the *Cincinnati* and *Raleigh* were very defective and the experience with these vessels had brought to the attention of designers in the most marked way the importance of providing for the human element. When the *Raleigh* and *Cincinnati* were being designed the writer had urged upon the then Chief Constructor the importance of increased length, so as to give proper room for the care and operation of the machinery. Even now he is of the opinion that to cut the vessels in two and lengthen them, say, 20 ft., would be good policy. The advantages of such alterations were apparent in the *Castine* and *Machias*, and in several well-known liners. It was valuable to find the views of the Chief Constructor on record so fully, as to the importance of real results in every-day performances, rather than phenomenal records for a brief trial. At the time the *Cincinnati* and *Raleigh* were designed the professional men of the Department were not in a position to take such a stand, but in the meantime many ships had been built and sufficient experience gained to warrant the stand taken.

George W. Dickie expressed pleasure at the stand taken by the Navy Department in the design of these cruisers, and naval architects in general, so far as he knew, were in accord with the Department. He was personally opposed to the use of soft wood for sheathing, and favored the use of teak. It had been suggested that this was not a home product, and the law required that the vessels be built of material of domestic manufacture. To this he would reply that the sheathing of electric wires in vessels of the Navy was composed of India rubber which was not of domestic growth at all. (Laughter.) Teak possessed wonderful properties for the preservation of iron and steel, and no other wood had this quality. "The wood itself is practically indestructible," he said, "and the renewal of sheathing on one of these vessels where so many fittings have to be removed is a very serious matter. When you spend a million dollars on a cruiser I don't think that the seven or eight thousand dollars difference between pine and teak should be considered at all." He did not think that the cost was considered, but that the matter was one of sentiment.

Naval Constructor W. L. Capps said the paper marked a "distinct increase in technical backbone." It showed a willingness to take less speed in the beginning than could be had, because those in authority believed the lesser speed was better. High speed was only obtained at the sacrifice of many vital characteristics, the most vital of which was coal supply. High speeds in the past were trial trip speeds and not cruising speeds. Under practical conditions they were obtained ordinarily in smooth water, with clean bottoms, highly trained crews, and picked coal. In actual service, conditions were, usually, foul bottom, ordinary crew and any coal that could be got. Referring to the *New Orleans* as a "very brilliant design," he said the large bunker capacity on that ship was obtained only at a very serious sacrifice in habitability. "The bunkers are raised aft above the protective deck and the men have to sleep on these in the tropics. I have just returned from a trip to the tropics under just such conditions as the *New Orleans* will have to confront, and do not at all envy the lot of people who have to sleep below—of course they will sleep on the upper deck and there they will frequently get wet." He believed that the change

in the policy was largely due to experiences in the late war. It was then shown that paper speed was not real speed, and that the coal supply was inadequate.

Captain Charles L. Ottley, R. N., followed and said: "Every officer who has had anything to do with squadron cruising, who has had much to do with the work of ships together, first of all plainly realizes that the speed of the squadron is necessarily the speed of the slowest ship, while an officer in command of a squadron who has to go from one place to another, if he is under orders to proceed with dispatch, wants to know what his maximum speed is. Upon that he can base his plan of operations whatever it may be. But what I desire to speak of and what I have seen many a time in squadron cruising is when an Admiral has put to sea we will say, with a number of ships of nominally 14 knots speed, these 14 knot flyers occasionally tail off in the most disappointing way. I entirely agree with the gentleman who spoke last as to the splendid line that the U. S. Government has taken—the people who are responsible for the designs here—in saying that the speed the ships are designed for is the speed they shall give under the critical conditions of the actual service. That, I think, is the point. I should like also to say that what Admiral Melville said in the memorandum read, about certain of our own cruisers that correspond to your *Raleigh* and *Cincinnati* class is perfectly true. The "M" class of cruisers, the *Magicienne, Melpomene* and *Medusa* class, were not everything that is to be desired. I think it is a matter of evolution, and as years go on of course we improve our ships, and no doubt we shall get very much better. But in any case I think what sailors all pray for is: 'for Heaven's sake don't give us a trial trip speed, give us a speed which we can have under all conditions,' and I think there is great hope of obtaining that in your new designs. You will know the speed the ships can go."

Walter M. McFarland: "Having read these remarks of Admiral Melville, it will perhaps be considered that my voice has been heard enough on this subject. But there is one point on which there is a tendency to be a little unfair. I think Admiral Melville in his paper called attention to it, and complimenting Chief Constructor Hichborn for drawing attention to the point, emphasized the fact that at the time some of these ships were built (which were not altogether satisfactory) everybody was young at the business. Mr. Bowles and myself helped on some of the earliest work done for our new navy. I remember very well the talks he and I had, and our doubts as to whether the results could be accomplished. But we were met every time by the statement: 'They are doing it abroad, and if you do not do it it will simply be a confession that people in the United States cannot do as well as people abroad.' It was perfectly useless to say that these ships would only make these speeds for a few hours. You were met with the statement that 'They are doing it abroad and you have got to do it.' So I do not feel that the designers in the Navy Department are to blame in the slightest degree, and as Captain Ottley says, it is a process of evolution. And now the time has come when we have had all this experience, and the general public as well as the experts are educated up to the point. Now we are in a position to recommend and to get it listened to, to do just exactly what really is right."

Arthur B. Cassidy: "I would like to say that I saw the official communication that the *Raleigh* was only able with difficulty to attain a speed of 9 knots. It was the official report of the commanding officer who stated that during the second half of the engagement he was barely able to make nine knots, and it was due probably to the foulness of the bottom and also to the heat in the fireroom and engine room, and he was obliged to give way for the *Baltimore* to precede him in the fight. Also on that same endorsement Admiral Dewey made the comment that the vessel ought never to have been allowed to leave the United States, in his opinion."

Mr. McFarland: "But these statements are misleading unless the whole truth is known."

Naval Constructor Francis T. Bowles said, he took it, the question which the Chief Constructor wished to bring out was the necessity for sheathing, and to take the *Raleigh* for that purpose seemed a trifle unfair. The *Raleigh* had other difficulties besides having a steel bottom. "I have always been opposed to the use of wood sheating on steel ships," he said, "and I still maintain that it is uneconomical and unnecessary and involves a great deal of danger to the ship. It may be desirable to have a few sheathed vessels, now that we are going to maintain a considerable portion of the Navy in the Philippines, until we get dry docks built there; but until the dry docks are built I will admit the necessity for sheathing vessels, and no longer. The questions at issue had been threshed out many years ago."

Fourth Technical Session.

On Friday afternoon the members were called to order at 2.20 o'clock, Walter M. McFarland in the Chair.

NOVELTIES IN SHIP FITTINGS.

BY ASST. NAVAL CONSTRUCTOR R. M. WATT, U. S. N.

Descriptions of improvements and developments in the fittings of naval vessels which have been adopted by the Construction Department at the Brooklyn Navy Yard are given by the author. Those selected for presentation in this paper include: (1) Watertight bulkhead doors operated by electric power; (2) Non-conducting, non-inflammable, non-splinterable sheathing for living quarters; (3) Metallic folding berth; (4) Watertight metal skylight. The requirements had in view in designing the door were: Door to be raised or lowered by power or hand by operator at door on either side of bulkhead; that door should close against a rush of water or through coal on the sill; that operation of the emergency (distant) closing should not interfere with usual local methods of operation; that while door is closing from distant station a man at the door can stop it for egress. Electricity was selected because of the "certainty of control." Cutting off current cuts off power—there is no expansion of fluid, no leakage of valves, etc., and there is no waste of energy when not in operation. The conductor can be readily run around sharp corners and clear of other fittings without frictional losses caused by bends. Breaking a conductor does not release steam or water or create noise. It is admitted that the electric device cannot be applied to all doors in a ship without increase in the capacity of the generating plant. As doors are operated only intermittently, however, by arranging the doors to work singly or in small groups

the system can be applied to the more important doors, by taking advantage of the overload capacity of the generators. Lord Charles Beresford, R. N., has said with reference to watertight doors: "The principle that should be enforced is that it should be possible to shut the door and secure it in one movement." This, the described arrangement accomplished—an operator at the door by pushing a button could close it by power. Another advantage in the electrically operated door is that every door is complete in itself, having its own line from the dynamo room and its own motor. In case of derangement the door could still be operated locally by hand, and one door put out of power operation would not affect the power operation of any other door in the system. With hydraulic transmission a break at the central station would render the entire power system inoperative, and with pneumatic transmission the results would be almost as serious. In construction this door is of the vertical sliding type, with vertical rack in which gears a pinion carried on a horizontal shaft extending across the door at the top of the guide frame. The pinion engages a smaller pinion keyed to a second horizontal shaft, placed slightly above the other, and on the end of this second shaft, outside the guide frame, there is keyed a worm wheel. In this a worm engages, the worm shaft passing through the bulkhead to an electric motor on the opposite side. The ends of the worm shaft are hexagonal, and for these hand cranks are provided. The door and frame are made exceptionally heavy, so as to avoid the possibility of sticking by the deflection of the bulkhead under pressure. The weights are: Door, 291 lb.; frame and gear, 600 lb.; actuating apparatus, 492 lb. Tightness is secured by wedging. The bulkhead frame guides are tapered over one-tenth inch to the foot, and the sliding frame is made with eleven wedges, of the same taper as the guides, which take up in the last half-inch of travel. Both guide frame and sliding frame surfaces nearest the bulkhead are scraped, and when wedged make a watertight joint. The electric controlling devices are described in detail by the author. These and the motor are all incased in watertight boxes. Doors of this type have been fitted in the U. S. S. *Atlanta*. (2) Regarding fireproof sheathing, etc., the practice now followed in the yard was to omit overhead ceiling, and in the crew's quarters the outboard sheathing. In officers' quarters asbestos sheathing is used, and divisional bulkheads are of corrugated metal. Metal is also substituted for wood in berths, ladders, skylights, lockers, and in one case, roll top desk. Experiments are to be made with metal furniture. Asbestos sheathing has been developed by the H. W. Johns Mfg. Co., and is now light in weight and clean, neat and ornamental in appearance, and further adds to comfort by being warm in winter and cool in summer. The weight of this sheathing, with framework and fastenings, averages 6 1-2 lb. per sq. ft. The sheathing consists of successive layers of galvanized iron wire cloth, asbestos fire felt, and asbestos millboard. The seams are covered by metal mouldings, and any interstices are filled with asbestos cement. The millboard is sized, and then painted with white enamel and gold striped. (3) The substitution of metal folding berths for the ordinary brass bedstead gives an increase in available floor space and stowage capacity, and involves a change in the outfit of furniture. Below the berth a shoe locker is fitted, and over the berth a cabinet. When not in use the berth folds up and is neatly hidden by a covering curtain. The additional space permits of the addition of a chiffonier and a locker or transom against the outboard side of the room. There is also supplied a secretary-bureau, metal toilet rings, metal fittings for toilet articles, and the usual china crockery. (4) Wooden skylights over the living quarters are objectionable, owing to leakage over berths and mess tables. This is due to the sudden changes of climate encountered by the naval vessel in service, to the frequent handling in drill in the case of raised skylights and to the jar in target practice in the case of sunken skylights. For these reasons a skylight of sheet copper has been experimentally fitted on the U. S. S. *Cincinnati*, which is water-tight, splinter-proof and non-combustible, neat in appearance, of no greater weight than wood, and gives a larger clear area for the passage of light. A number of explanatory photographs accompany the paper.

DISCUSSION.

Mr. Thomson said incombustible fittings were being used in the Russian battleships under construction at Cramps. Asbestos sheathing is used entirely next the ship's side, and asbestos millboard as the dividing bulkhead between staterooms. All the furniture except the chairs is made of metal, and the decks below the spar deck are sheathed with aluminum, so that the only woodwork on the ships is the deck plank on the upper deck.

Mr. Mackay said, in connection with the operation of the bulkhead doors by electricity, the point was raised whether in case a number of doors were closed in an emergency there would result an excessive demand on the generating plant. This had been considered in designing the electrical fittings for controlling the system, and it was found there were a number of considerations which would bring down the maximum demands for any reasonable number of doors to within the limits of an electric plant on board a ship. The doors could be arranged in groups, say of five or six doors, to be operated by a single push-button and, owing to slight variations of speed in the several motors of one group, it would be very improbable that all the doors would seat at the same instant. The amount of current needed at the instant of seating was greatly in excess of that required to simply close the clear way of the door, but the duration of this required excess was for the fraction of a second only, and probably not more than two or three doors would seat themselves simultaneously. In any event the maximum power capacity required at the generating plant to operate any number of these doors would not exceed one kilowatt for each door, and for an installation of twelve doors experiments had indicated that not more than nine kilowatts would be required. It was unlikely that any ship having, say ten of these doors, would have a generating plant of such small capacity as to be entirely loaded at the moment when the doors were put in operation. In the case of naval vessels the large reserve electric generating plant usually installed would warrant the introduction of the electrically operated door system, without having regard to the overload capacity of the ship generators.

Mr. Erhardt spoke of the advances that have been made in the manufacture and application of asbestos millboard for bulkheads. It was now easily handled without fracture, easily repaired, and could be washed and scraped clean just the same as joiner work.

W. B. Cowles said an objection to the vertical sliding door tightened by a wedge was that when the bulkhead warped the door would jam. He did not know of any possible way of preventing a bulkhead from warping on a ship during her service, while afloat in different conditions in a seaway, and in dock, and a door which did not take account of this was not a door suitable for power operation. For operating doors by power he preferred compressed air to the direct application of electricity, especially where five or more doors had to be operated. He could use electricity with far greater economy to store the air, and thus there would be no draft in time of emergency on the generator capacity. Air also could be led to the doors with less expense and no more interference with surroundings than electricity, and as a fluid it lent itself to a direct push and pull—the work to be performed. He regretted that a more extensive installation had not been used on the *Atlanta*, that vessel not having sufficient generator capacity.

Naval Constructor Francis T. Bowles accepted the responsibility for the invention and installation of the electric system, and said he merely wished to "point out" the difficulties that probably many present had incurred in storing air. (Laughter and applause.)

Assistant Naval Constructor Watt in closing said that the power door had come to stay. It relieved the men of manual labor, and for that reason they kept it in working condition. It was adopted to lessen the complications on board ship, and made use of the form of power which appeared to be coming into use everywhere outside of the engine and boiler rooms. Warping of the bulkhead had been met by a rigid frame of great weight, and it would be easy to increase the scantlings if need be.

PROGRESSIVE SPEED TRIALS OF THE U. S. S. "MANNING."

BY PROF. CECIL H. PEABODY.

This paper is in the nature of a contribution to the collection of data in the proceedings of the Society—a statement of facts and figures. The *Manning* is a seagoing revenue cutter of the following dimensions, etc.: Length, overall, 205 ft. 6. in.; beam, moulded, 32 ft.; draft on trial, 12 ft. 4 in.; displacement, 1,000.7 tons; wetted surface, 7,273 sq. ft. Engines are triple expansion, with cylinders 25 in., 37 1-2 in., and 56 1-4 in. dia., and 30 in. stroke. The propeller is 11 ft. dia., with hub 1 ft. 10 1-2 in. dia., and the pitch is 12 ft. 4 in. The trials were conducted by the author, assisted by members of the staff and graduate students of the marine department of the Massachusetts Institute of Technology. Shortly before the tests the vessel was docked and cleaned and the machinery was put in good working condition. The trials took place in June, 1899, over the measured mile maintained by the Bath Iron Works at Southport, Me. The course is sheltered, has abundant depth of water, and the configuration of the shore and islands guards it against tidal currents. Local landmarks determine the course, and white range poles on shore show up against a background of pines. Trials were conducted in good weather, and there was no perceptible tidal current. The observations taken were: Time required to pass over the course; revolutions and power of engine; steam pressure and vacuum, and form of wave profile. The time was taken with stop-watch from the bridge, revolutions from engine counter, steam pressure and vacuum from engine-room gauges. Two complete sets of indicators were carried, so that in case any indicator showed signs of failing the man in charge could immediately substitute for it a perfect instrument. It was the intention, well carried out, to take five or six diagrams from each end of each cylinder during every run. This the author holds to be a matter of great importance, as the difficulties and uncertainties of determining the I.H.P. are much greater than the corresponding errors in measuring speed. In all fifteen runs were made at speeds varying from less than 7 knots to a maximum of 16 knots, which last was obtained with natural draft and without distress at the engine. For the maximum speed the results showed: Revolutions, 152; equivalent mean effective pressure, reduced to L.P. piston, 38.26; steam pressure near engine 143 lb., and vacuum, 24.5 in. An analysis of the trials gives the following values for distribution of power at the maximum speed: Indicated horse power, 2,181, apportioned thus: Initial friction, 97; load friction, 146; friction and resistance of propeller, 503; wake-gain and thrust deduction, 214; skin resistance, 539; wave-making resistance, 682. The method of working up the results of the trials is gone into in detail, showing the mathematical formulæ employed and their application, and analyses of the trials, both numerical and graphic, are included.

DISCUSSION.

Prof. William F. Durand was called on by the Chair, and he said by way of comment: "When we have a body of data relating to one specific investigation, presented in the degree of fulness that this is, so that we may be able to use it for any purpose for which such a data may be used, it is a distinct and definite advantage. Beyond this, in regard to the matter of the analysis of this data there are only one or two points that I will briefly refer to. One of the chief points made out by this mode of analysis is the determination of the wake factor. From my own studies of this matter, both by this method and by another somewhat similar method, slightly differing in detail, I have always felt that it was difficult to satisfactorily determine this wake factor, simply due to the nature of the relationship between the quantities involved. They are involved in such a way that to work backward from the power is necessarily a somewhat delicate task. We cannot help that. It is in the very nature of the case. I most heartily agree with the sentiment expressed by the author of the paper that we should hope for more definite data—better information on this point from actual direct experiments rather than by working backward from the data derived from a progressive trial. This seems to be due to the fact that a considerable variation in this wake factor only leads to a rather moderate variation in the performance of the propeller; while, *vice versa*, a moderate difference in the perform-

ance of the latter may involve a relatively large disturbance of the wake value. This has its compensation, of course, in practical designs, due to the fact that we may make a moderate error in our treatment of the wake without very seriously endangering the final efficiency of our propelling apparatus.

"In regard to the assumption that the thrust deduction and the wake return are equal, I quite agree with the author of the paper that in the light of our present experience we cannot do better, perhaps, than to accept this as a temporary adjustment. We have no right to assume, and of course we do not assume, that they are fundamentally equal or that there is any particular reason why they should be. In the light of the present data that is before us it is a very difficult matter to determine the difference between them, and, simply, while we are waiting for direct experimental investigation covering a wide range of value, we cannot do better than temporarily assume that this difference may be omitted, feeling sure that it is undoubtedly less than the necessary error of observation as pointed out by the author of the paper. We of course are not going to be satisfied with this as a final view. We must simply wait until direct experiment, and not the indirect analysis which results from progressive trials, shall provide us with something more satisfactory."

Chairman W. M. McFarland: "It is a pretty difficult thing I know for people who are engaged in the actual work of building to discuss a paper like this; so that I am sure the author will not feel slighted, because many members do not get up immediately and discuss it. I have felt myself that the value of such papers is underrated. Persons engaged in the hard work of the profession sometimes think that all these mathematics 'don't amount to anything,' but, as a matter of fact, they do. There are always some men who combine the mathematician and designing engineer to such an extent that they can make good use of this research."

TACTICAL CONSIDERATIONS INVOLVED IN TORPEDO BOAT DESIGN.

BY LT. A. P. NIBLACK, U. S. N.

In introducing his subject the author refers to the extension of the facilities for torpedo boat construction both at home and abroad. Formerly this work was confined to a few specialists, whereas now "almost any shipyard" is prepared to construct such vessels, and this naturally has caused diversity in methods and types. The individuality, not only of torpedo boats but torpedoes, makes it imperative that much practice be had with any given boat and torpedo to insure the effect of hitting. The most effective torpedo for boat use today is a 16 ft. long, 18 in. dia., carrying an explosive charge of 110 lb. gun cotton. A maximum air pressure in the flasks of 1,500 lb. per sq. in. gives speeds ranging from 30 knots for 400 yards to 26 knots for 1,000 yards. Much diversity exists in sizes, shapes and destructive capacity. "The torpedo is not a delicate instrument," the author declares, recent improvements having carried it out of this classification and given it a "secure and permanent place in naval warfare." The paper now refers to the application of the principle of the gyroscope, to the steering rudders of the torpedo, and to improvements in launching torpedoes under water from moving vessels. The former first made use of in the Howell American torpedo, as the source of power, was later applied as an attachment to the Whitehead torpedo by the Austrian Navy. This gear, in the opinion of a U. S. naval commission, "improved the performance of the torpedo 100 per cent." Further improvement, the author believes, will give an effective range of 800 yards, instead of the present limit of 500 yards. Attention is next called to the necessity of making torpedo attacks in groups of boats, a single boat only attacking as a forlorn hope—a matter lost sight of in the United States. An attack, to have a reasonable chance, must be a surprise; hence darkness, fog, mist, snow and rain are favoring conditions. In approaching to attack causes of alarm to be avoided are: White wave bows, smoke, flame, and the hum of machinery. When discovered or within striking distance high speed is important, but is not instantly obtainable. "As between 20 and 30 knots speed the time to cover 1,000 yards is only as 90 to 60 seconds—can the 30-knot boat pass from 20 to 30 knots in 30 seconds?" If three 22-knot boats cost only as much as one 30-knot, and increased numbers increase chances of successful attack, is it not wise to forego phenomenal speed? "The craze for speed is illogical and tactically indefensible; * * * * people who handle torpedo boats have never sanctioned it." What is needed, in the author's opinion, is the building of groups of boats of similar design, with standardized fittings, with a view finally to building boats in groups with interchangeable parts. As to twin screws vs. single screws, the author refers to foreign practice, in which the latter is largely adopted for boats up to 140 tons. The addition of bow rudders in the Schichau boats, for example, improved the manœuvring powers considerably. Advantages of the single screw type included: Saving in machine weight and space; fewer moving parts, therefore less chance of breakdown; smaller crew; saving in oil effected. One drawback, however, was the necessity of relatively great draft. Details are given of the system adopted in Germany, where boats are built in groups, of like design, with interchangeable parts. Reserve boats are always kept ready for service, in the water, except when undergoing repairs. In winter they are kept at a uniform temperature by steam coils with shore connections. In Germany and Italy fuel oil has been extensively used, and experimentally in Russia. "This country, of all others, might well adopt liquid fuel." Its comparative efficiency as compared with coal is as 2.27 to 1. For the same stowage it adds 60 per cent. to the radius of action of a boat. The compressed air system of feeding is to be preferred—an air compressor must be carried, anyway, and the steam jet wastes fresh water. The capacity of distillers and tanks of a boat is of vital importance. Desirable characteristics for a first-class seagoing torpedo boat are: Smallness of target; small bow wave; minimum of noise, and no flame or smoke from stacks; large fresh water capacity, tanks and distillers; reasonable bunker capacity, designed for future use of liquid fuel; habitability, well considered; moderate, reliable sea speed without forcing. A speed of 22-23 knots on 110 tons maximum displacement for sea-going class, and 45 tons' displacement for harbor defense type is recommended, and the *Morris* and *Talbot* are named as ap-

proaching the ideal in the respective classes. Since 1893 the size of torpedo boats has increased very considerable. Every effort should be made to get the torpedo boat out of the "refined machine" category—"cavalry do not use race horses." To be in accord with modern tactical and strategical ideas we need: Sea-going boats for coast defense, second-class boats for harbor defense, and torpedo boat destroyers to operate from a fleet as a base.

In the absence of the author who is on duty in the Philippine Islands the paper was read by title.

DISCUSSION.

Charles P. Wetherbee had read the paper very carefully and regretted that the author was not present to answer questions. The author at the outset had apparently given the preference to the single screw boat, and yet at the close of his paper had referred to the *Morris* as the ideal type of boat for moderate speed—yet the *Morris* is a twin-screw boat. Continuing, the speaker said:

"Lieutenant Niblack evidently calls for 22 knots, and he speaks in this paper as if he expected that a boat built to go 22 knots could steal up on an enemy at that speed without any difficulty. I have had some experience in both designing and running boats of that type, and when you are running a boat that is designed for 22 knots there won't be much creeping up. (Laughter.) I think the policy that probably would be the most satisfactory, if he wants a 22 knot boat for actual service, is to call for about 25 or 26 knots from the contractor, and that will give him a boat which will go very nicely at 22 knots, because you are not going to have a boat in an emergency that you can bring up to actual trial speed. If you have a 25 knot boat from the contractor she will not flame at the stack and will not give any bad bow wave at 22 knots. Everybody knows that a bow wave is a very bad feature. I have been connected with a 30 knot boat and have found that we could only steam along at 22 knots all day with the stoke-hole open, and she will do 25 knots with any kind of dirt you put in her and not flame at the stack at all."

John Platt was called upon by the Chair, and in response said that the whole development had been toward a very much larger boat, and he believed that in England for the last four years no torpedo boats were built at all; or, if any had been built, it was only to replace boats of an earlier type. The whole disposition was to build a much larger boat, which is a torpedo boat and capable of high speed and is satisfactory at sea. He referred to the statement of Mr. Wetherbee, which he took to mean that a 30-knot boat could not reach that speed without flaming at the stacks, and such. Taking the conditions imposed in the British Navy, this was not so. There the boats had to make their speed on a given coal consumption with a given load—a consumption not more than 2 1-2 lb. per horse power. It was not possible to get below 2 1-2 lb. and have flaming at the stacks. These onerous trial conditions had the effect of producing boats that could reach their speed under fairly economical conditions, provided, of course, that the bottom was clean and that the screw propellers were correctly designed. The falling off in speed, however, under any conditions should not be more than two knots.

George W. Dickie, who was asked for an expression, said he was out of the torpedo boat business. "At last year's meeting of this Society I presented a torpedo boat," he continued. "She made a trip across the Atlantic; she was seized there by a Scotchman, and he took the Thornycroft boilers out of her and put in Scotch boilers. He sent her to the Institution of Naval Architects and she was there dismantled. Since then I have lost a great deal of interest I had in this question. I think, however, that if that class of boat is built at all they must be built so that they can go to sea and stay at sea, and make a sea voyage when they are wanted to without waiting for weather conditions, and that they should be able to accompany a fleet wherever that fleet should be sent. While we have been modifying the boats —it is the torpedo boat destroyers I am thinking of just now— in this country, and the latest ones have been improved very materially, I think that there is a wide field to go on in the same direction, so that we can have torpedo boats in which officers and crew can live comfortably, that they can feel at home in, and that they can be ready whenever they are ordered to go where they are wanted, and in any kind of weather."

Mr. Kemble believed that it would be wise to sacrifice some speed for protection, say, a drop from 28 to 24 1-2 knots actual sea speed; and this would allow a 1-2 in. nickel steel protective deck, thereby increasing the confidence of the personnel, and greatly increasing the ability of the boat to deliver her attack.

John C. Kafer pointed out that the *Furor* and *Terror* as boats which in actual service fell far short of their reported trial speeds. He agreed with Mr. Dickie that what was required was a boat that would give speed whenever it was needed.

John Platt said the *Farragut*, built by the Union Iron Works, similar to a British boat, had given 31 1-4 knots on trial for a considerable length of time, and that this speed was never attained by a similar boat in England.

Mr. Wetherbee said his experience was, that, owing to inexperience, we could not get as much in the way of speed out of boats as foreigners did—they had the advantage of a very experienced personnel. In the matter of speed reduction he did not mean that a naval crew could not get within four knots of trial speed, but that if the Government would contract for a high speed they would get a boat that would go along very easily at, say, three or four knots less. As to the size of screw there was much opposition here to a considerable draft of water in a boat, caused by the need for our boats to pass through canals. A single screw boat, such as referred to by Lt. Niblack, would need a draft of about 8 ft. in order to get a decently efficient propeller.

Naval Constructor W. L. Capps believed a commanding officer would hesitate to force his boat up to a 30-knot gait, for fear of a smash-up. There was room for development along the line of increased strength of parts, and two types of boats would be useful—one 100 tons and the other about 500 tons. The larger boat would be strongly built, and would have large capacity for fuel and water.

Captain Charles L. Ottley, R. N., presented some views gathered from the work of torpedo boat destroyers on the coast of Crete, in the Mediterranean, during the blockade: "As Mr. Dickie said just now, what is desired is to have a class of boat which shall be able to accompany fleets, and act with fleets. On the Cretan

blockade we brought our destroyers up from Malta. We kept them on that coast. The coast of Crete in wintertime is very nasty. Sometimes, especially on the northern coast, gales of wind come up suddenly. Our torpedo boat destroyers were there pretty constantly, and were of the greatest possible use. Of that there is no question. They were extremely useful in carrying messages from the bigger ships up and down that coast. What I wanted to say was that they practically wore themselves out over that business. I assure you that whatever may be done in times to come, any officer who has had anything to do with those boats in actual war conditions, or conditions nearly approaching to it, as it was then, will tell you the same thing. The captains of those boats absolutely wore their boats to pieces. The boiler tubes gave out. A boat would be brought into Canea Bay and the machinery patched up, and out she would go again. I think we are far from having got hold of a design of torpedo boat destroyer which can be said to accompany fleets any long distance. I think our policy in England is that the type of destroyers should act in the narrow seas, should be at the nearest points, and that a telegram can be sent to that point to a torpedo boat: 'Your objective will be at sea at such and such a point.' But at present torpedo boat destroyers are not much further on than that.

"Then there was one other point, and that is the question whether by reducing speed you could take some of the weight so gained and put it on in the form of armor plating. The armament of a torpedo boat destroyer consists, usually, of somewhere about half a dozen 6-pounders and one 12-pounder. I remember being one of a number who were in favor of putting in a bigger gun. We were asked: 'What do you want to put a 12-pounder in there for? A 6-pounder will go through any torpedo boat.' The answer was, that from actual practical experience it was found that a 6-pounder would go through the side all right, but would not vitally damage the machinery or the boilers. The boiler of the boat was so thick that nothing but a 12-pounder would go through it. You see a 12-pounder would go through a good deal more than half an inch of nickel steel. It means you have got to protect your boats so heavily to protect against the 12-pounders that I am afraid you would lose in speed considerably."

Chairman W. M. McFarland, at the close of the discussion, said the torpedo boat was in an unfortunate condition—it was wanted to do such an infinite variety of things. One wanted to drive it as fast as possible; another wanted to use it for a despatch boat—a combination of racehorse and roadster. The troubles referred to by Captain Ottley at Crete were similar to those experienced by our Navy on the coast of Cuba. Torpedo boats were used as despatch boats in all sorts of weather. On one occasion, he was informed, the *Ericsson* come in from twenty-four hours' despatch duty in very rough seas. She tied up to the dock, and immediately the officers fell down asleep on deck at the stern, and the men fell down asleep at the bow. It was not much wonder that things got out of order used in that way.

ON THE ACTION OF THE RUDDER.

BY PROF. W. F. DURAND.

The author prefaces his paper with the statement that "our knowledge of the forces which act on the rudder is dependent almost entirely on a few scattered experiments on widely separated types of ships." An estimate of these forces is necessary in the design of the rudder and attachments, more especially of the steering engine or motor, both in regard to the power which it must develop and the moment which it must be able to exert on the rudder stock. The available data is insufficient to furnish any satisfactory empirical theory, though an incomplete theory has been widely adopted, based on Joessel's experiments which give the forces acting on a plane placed oblique to a moving stream. In the paper the formulæ resulting from the application of the results of the Joessel experiments to the case of the rudder are given in detail, and are discussed in various ways. The chief difficulty in making direct application of these results lies in the fact that the angle between the rudder and the flow of the stream in which it moves is not equal to the helm angle, but is less by some unknown and variable amount. This reduction, the author shows, is due to the sidling motion of the ship, moving under the influence of the rudder, in consequence of which the inclination of the rudder to the line of flow at the stern is less than its inclination to the keel. For this reason the use of the helm angle in formulæ derived from the Joessel experiments gives forces much larger than those obtained by observation. The ratio between the actual force ascertained by experiment and the value derived from formula is termed the "coefficient of reduction." Recorded trial data for the purpose of such determination is limited to less than a dozen different cases. and an abstract of these is given in the paper. In the absence of such data the author suggests that for purposes of design the forces may be approximated to by the use of the formulæ referred to and by the assumption of what may seem to be a suitable coefficient of reduction. If the characteristics of the motion of the ship while the helm is being put over could be determined, the extent of the reduction in the obliquity of flow—due to the sidling motion of the stern—could be found and an approximation made to the value of the coefficient of reduction for that particular case. To map out these characteristics, however, would require the use of equations so numerous and so related that "they seem to defy all attempts at analytical solution." The author, therefore, supplies a special method for the treatment of differential equations of this character, so that a very close approximation can be reached in any given case. To illustrate this the case of a vessel of 8,000 tons' displacement is worked out in the paper, and details of the movements of the vessel during the period while the helm is being put over are shown graphically. From the work accomplished several deductions are drawn by the author. "The reduction of forces will be greater, as the rudder is larger relatively to the size of the ship, as the speed with which the helm is put over is less, as the speed of the ship is greater, and as the ship itself is smaller, while the reduction will be less under opposite conditions. * * * * * The reduction in speed during the time necessary to put the helm over is quite inconsiderable." In closing, the author refers to the limitations of purely mathematical treatment, "for only as experimental values are available to furnish a constant control over the abstract relation are analyt-

ical methods of practical value." He makes an earnest plea for further experiments, especially at speeds of 20 to 30 knots.

DISCUSSION.

Prof. Cecil H. Peabody, in response to a call from the Chair, said in discussion: "It appears to me that the paper itself and the explanation of it which has been made by the author are such as to require very little in the way of general statement. Of course, a complete discussion of this will go into theoretical and mathematical work in a manner which might not be necessary or desirable now. It does, however, seem to me that a thing might be said that the author might hesitate to say for himself. It is clear enough that the experimental work on which this is based is incomplete, and to an extent unsatisfactory; that the comparison of the experiment is more unsatisfactory, as referring to only isolated tests, and a few of them, and it would occur to us to ask why all of this work should be done. It is not pointed out by the author that he has given us some tools which will be ready when we have a chance to use them. Even though the entire set of equations here shall need to be re-cast the methods remain, and that is a distinct addition to our knowledge."

George W. Dickie wondered whether, "if we knew exactly how many foot pounds were required to bring a rudder over, under certain conditions of speed, and certain area of rudder, whether we would reduce the size of our hydraulic cylinders or our steam cylinders for operating rudders?" He had no recollection of any gear that would not bring the rudder over—they seemed to be on the safe side all the time. Three or four sizes of steering gear generally carried the builder through all the range of ships that were built.

F. L. Du Bosque inquired whether any consideration was given, in the paper, to the shape of the ship in calculating the effective effort of the rudder. It was a common experience with those who had to do with canal boats to find that they required a rudder about three times as large as a finely formed boat of the same length.

William F. Durand, replying to the query of Mr. Du Bosque, said the equations given provided for the introduction of the feature referred to; but engineering judgment was demanded in the application of the equations to any given case, so that the necessary corrections for differences of form could be made. As to the remarks of Mr. Dickie, the speaker had pointed out in his paper that these matters could be considered from two standpoints—the strength of the parts and the capacity of the motor. With regard to the first-named this refinement could not enter into the question. Experiment had shown that, due to the action of the waves and other causes, stresses three times the normal were likely to occur at any moment, and it was necessary in designing the rudder stock and other parts to employ a large factor of safety. As to the capacity of the controlling motor, however, it might be more justifiable to proportion the motor to what might be termed the "average resistance," rather than to the exceptional. This was a matter for the designer, and in this investigation the speaker had satisfied himself with an effort to provide an instrument of examination and research.

CLOSE OF THE MEETING.

This discussion closed the technical sessions, and the customary votes of thanks to the Presiding Officer and the Secretary were passed with great heartiness. On motion of John Kafer, the Chairman announced the seventh general meeting adjourned.

Obituary.

With the death of William H. Webb, shipbuilder, which occurred October 30 last, the dean of the profession in America has passed away. The great name and fame of the deceased as a builder of ships was worldwide long before the present generation took any interest in vessel construction. Mr. Webb was born in 1816, in New York, of New England stock. He early engaged in shipbuilding, and more than half a century ago he had the design of some of the fastest clippers of the day to his credit. During the many years of his active professional life he designed and built more than 150 vessels of all classes in his yard at Sixth street, on the East River, New York. These included every variety of merchant vessel, sailing ship, sound steamer, ocean liner and smaller craft, and also many powerful war vessels for foreign governments. His masterpiece, perhaps, was the war vessel *Dunderberg*, sold to France and long retained on the active list of that nation. This was a steam screw vessel, and in her construction were embodied many improvements that in later days have been put forward by others as novelties. Since his retirement from active professional life Mr. Webb had devoted himself largely to charitable work. Much of this was done so privately that few knew its extent. His most public act was the establishment of the home for indigent shipbuilders and for the technical education of young men, without charge, at Fordham Heights, New York City. This institution, widely known as Webb's Academy and Home, was described in a recent issue. Deceased left a large fortune.

General Thomas W. Hyde, shipbuilder and principal owner in the Bath Iron Works, Bath, Me., died November 14, at Old Point Comfort, where he had gone for his health. He was born in Italy in 1841, and he was educated at Maine schools, later at Bowdoin College, and completed his studies at Chicago University. Soon afterward he received a commission in a Maine Regiment and served with distinction during the Civil War, being granted a special medal for bravery by Congress. After the war he returned to Bath, Me., and entered the iron business, first with the Bath Foundry, and later with the Bath Iron works. General Hyde took an active part in state politics, and served several terms in the State Senate. He had a very wide circle of both business and personal friends, who hold his memory in high esteem.

A report has been made by the U. S. Naval Board upon the Holland submarine torpedo boat, and this is now under the consideration of the Board of Construction. Chief Engineer John Lowe has reported favorably on the boat, and urged the construction of a number of these boats for harbor defense.

It is planned to hold an International Congress of Naval Architects and Constructors under the auspices of the French Government at the 1900 Exposition in Paris. Those who desire to participate are requested to communicate with M. Hauser, Secretary, 4 Rue Meissonier, Paris, France. All papers must be in before June 1, next.

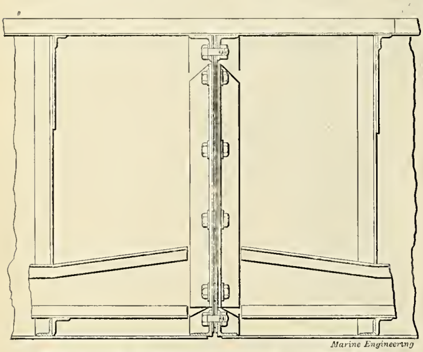
WHITE STAR LINER BRITANNIC, IN SERVICE AS BRITISH TRANSPORT, LEAVING QUEENSTOWN WITH ROYAL IRISH RIFLES, FOR SERVICE IN SOUTH AFRICAN CAMPAIGN.

Many of our readers will recognize the steamer in the foreground of the accompanying photograph, the famous old transatlantic White Star liner *Britannic*. She is now in the service of the British Government carrying troops to South Africa, and is officially labeled "Transport No. 62." In the view she is starting from the mail steamer wharf at Queenstown on her 6,000 mile voyage to the Cape of Good Hope, and just beyond her the port guard ship lies at anchor. The South African war has caused the temporary removal of many vessels in the transatlantic trade, and has had a serious effect on ocean freights. In modern times no transfer of troops by sea has been of such magnitude. To date, transportation for about 50,000 men, with all the necessary equipment of horses, guns, munitions of war, and stores of every conceivable description, has been provided. About 150 vessels have been engaged for the work, ranging from the freighter of 1,500 tons up to the magnificent White Star liner *Majestic*, and the total tonnage is about 700,000 tons. Two of the regular mail steamship lines connecting England and the Cape—the Castle line and the Union line—own considerable fleets of large and full-powered vessels, and these, of course, were made use of extensively by the British Government, and they formed the nucleus of the transport fleet. From the transatlantic service a large number of vessels were drawn. Seven of the Cunard boats were chartered, including the *Servia* and *Aurania*. The Anchor line furnished three, including the *City of Rome*, and the White Star line two mail steamers and two freighters. Other well-known vessels chartered are the National liner *America*, Atlantic Transport liner *Mohawk*, Furness, Withy & Co.'s *Rapidan*, Leyland line S. S. *American*, Dominion liner *Englishman* and Allan liner *Bavarian*, and others. The average size of vessel is nearly 5,000 tons.

SHALLOW DRAFT STERN WHEEL STEAMERS AND BARGES FOR MEXICAN GOVERNMENT.

One of the evidences of the present boom in shipbuilding is the spreading out of this art into territory which, in recent times at least, has not been included in the shipbuilding statistics. A case in point is the construction of a fleet of five stern wheel steamers and twenty lighters, on order from the Mexican Government, by the Johnson Iron Works, located at Algiers, La., but within the corporate limits of New Orleans.

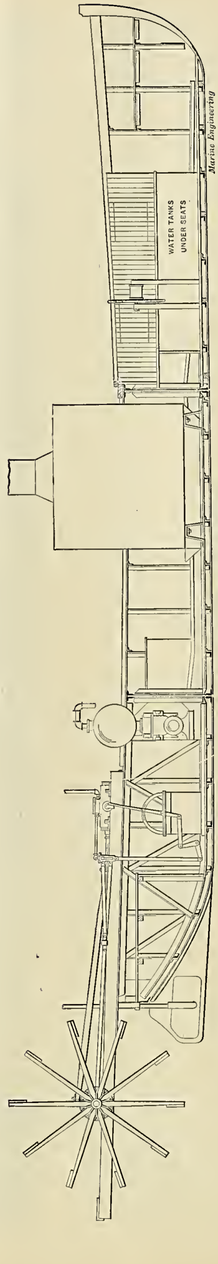
In the accompanying engraving we show these interesting little vessels in various positions when completed and ready for shipment by steamer to their destination. They were all built of steel, each in sections dividing the length into three parts. In dimensions the steamers are as follows: Length, 34 ft.; maximum beam, 10 ft.; depth, 3 ft. The lighters are of similar dimensions as regards length and depth, but are of 1 ft. greater beam. The steamers were built of 3-16 in. plate throughout and the lighters of 3-16 in. plate and No. 8 plate.



ENLARGED SECTION THROUGH BULKHEADS.
DETAILS OF SECTIONAL VESSELS.

The rivets were 3-8 in. and were all driven hot, flush on the outside to countersunk rivet holes. In design the lighters have sharp bows and square knuckles, the steamers having round knuckles.

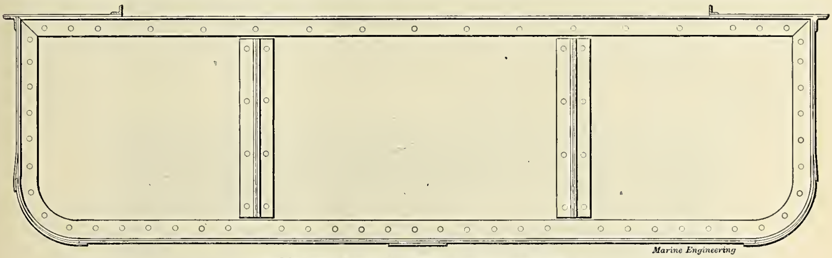
In the case of the lighters each section has a fore and aft bulkhead of No. 8 plate, and a cross bulkhead at the union of the sections, the cross bulkheads being close riveted to a 3 by 2 1-2 in. angle frame with welded corners. These welded frames carry a series of holes for 3-4 in. screw bolts, spaced on the bottom and sides 4 in. between centers, so that the sections are readily bolted together through these frames. An angle 3 by 2 in. runs across the top of the bulkhead plates and is securely riveted to them. The fore and aft bulkheads are fastened to double 2 1-2 in. angles riveted to the cross bulkheads at their centers. Holes for 3-4 in. bolts, spaced 8 in. between centers, are drilled through the top angles of the cross bulkhead plates and through the 2 1-2 in. vertical angles of the fore and aft bulkheads. The top edges of the plates of the lighters are finished with a 2 1-2 in. angle riveted in place and terminating at the end of each section length. A gusset



LONGITUDINAL SECTION.
STERN WHEEL LIGHT DRAFT RIVER STEAMER, FOR MEXICAN GOVERNMENT, BUILT AND ENGINED BY JOHNSON IRON WORKS, NEW ORLEANS, LA.

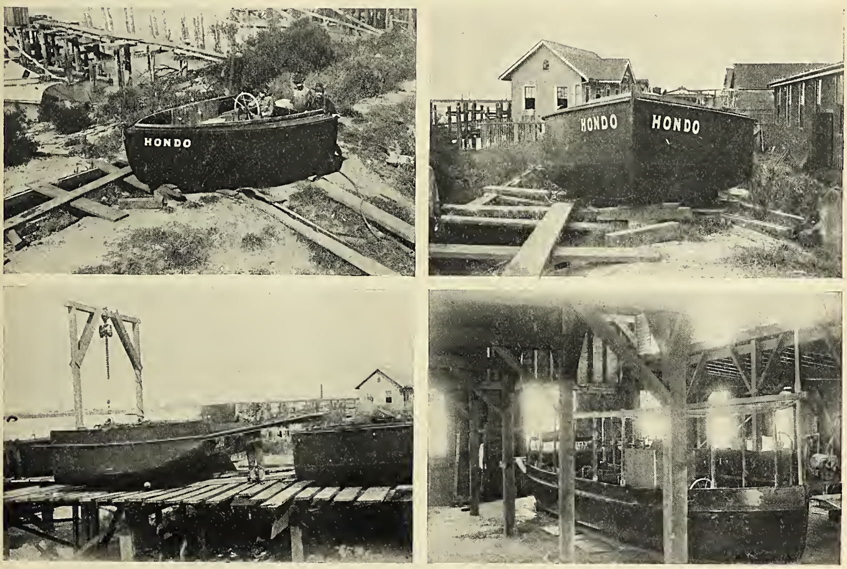
plate lapping the contiguous fore and aft angles, and the cross bulkhead angles on their top sides will be riveted in place when the lighters are finally put together at their destination.

A similar method of joining the sections together has been adopted in the case of the steamers. These latter are equipped each with a Roberts water-tube boiler built for 200 lbs. working pressure, and stern wheel engines, with cylinders 4 in. dia. and 16 in. stroke, fitted with balanced slide valves. The stern wheel is 6 ft. dia., and is fitted with buckets 6 ft. long, and when running loaded the engines will turn at 39 revolutions per minute. Each steamer is equipped with an independent combined surface condenser and air pump of sufficient capacity to maintain 26 in. of vacuum on trial. On trials for speed, in slack water, the steamers attained a speed of nearly 7 miles per hour, and with a lighter in tow containing 60 men, a speed of 5 3-4 miles was attained.



CROSS SECTION AT BULKHEAD FRAME.

DETAILS OF FRAMING AND PLATING OF LIGHT DRAFT RIVER VESSELS.



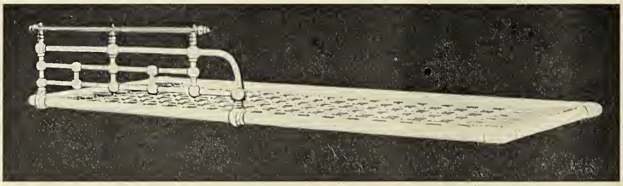
PHOTOGRAPHS OF SECTIONAL RIVER STEAMERS FOR THE MEXICAN GOVERNMENT.

The carrying out of this contract successfully is very creditable to the enterprise and skill of this establishment. When the contract was made, March 29 last, there was no equipment on the ground suitable for turning out this class of work. A building was speedily put up, however, and meanwhile the necessary tools and apparatus were purchased and installed. Steam was raised in the new shop and the actual work of construction commenced about the middle of May. Serious delay was experienced in the delivery of material, but in spite of this the entire contract was completed within the guaranteed time and the vessels were all ready for delivery early in September.

IMPROVED APPARATUS.

Metallic Steamer Berth.

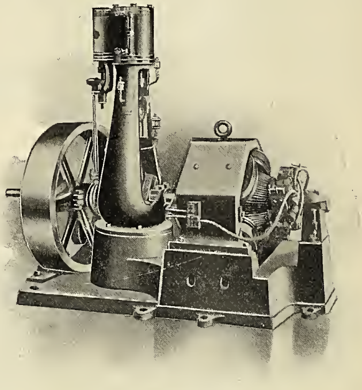
An improved form of metallic steamer berth is shown in the illustration of a standard berth made by the Hartford Woven Wire Mattress Co., Hartford, Conn. This is composed wholly of wrought iron and malleable castings, with steel netting for bed bottom, and fine quality oil-tempered helical springs at the ends of the netting. The springs are attached to the frame by a series of hooks on the ends that are counter sunk into the wrought iron and riveted down, making a smooth finish on the end. The frame is composed of wrought iron tubing 1 3-8 in. outside dia., and the sides of the same material; the outer band of 5-8 in. and the filling of 1-2 in. material. The top bar is of brass either nickel plated or lacquered. As required, the berth is made to fold up or remain open permanently. Among the advantages claimed for it are that it is aseptic and vermin proof. If desired the berth is supplied with an attachment which can be screwed to the joiner work making it a permanent fastening without any other casing being required.



HARTFORD WOVEN WIRE STEAMER BERTH

Racine Automatic Engines.

Our engraving shows a direct connected lighting set in which motive power is provided by a Racine automatic high speed engine. This is a specialty of the builders who manufacture a range of sizes from 2 to 37 horse power. The engine is compact in design, having a self-contained base which provides a rigid foundation for both engine and outbearing, so that the latter cannot get out of line. The frame is rigid and of neat appearance, and in process of manufacture the cross-head guides, the frame faces, and crank shaft boxes are machined at one setting, insuring accuracy of alignment. A piston valve is employed, the clearance spaces being reduced to a minimum. The connecting rod is a flat steel forging, and the crank pin boxes and small end bushing are composed of a special alloy. Charcoal iron is used for the cross-head with shoes of special bearing metal and the pin is of hollow steel, with oil holes in the top surface, the pin and bushings being lubricated from a convenient end oil cup. A Rites patent fly wheel governor is fitted and is guaranteed to regulate within 1 1-2 per cent from no load to full load. The center crank is a solid steel forging and is fitted with automatic lubricator. The engine, with cylinder 7 in. by 7 in. and turning 350 revolutions at 85 lbs. boiler pressure, cutting off at quarter stroke, is rated at 17 horse power. With two pulleys it occupies 34 in. by 49 in. floor space, and measures 5 ft. 4 in. in height. The shipping weight is 1,650 lbs. The manufacturers are the Racine Hardware Co., Racine, Wis.



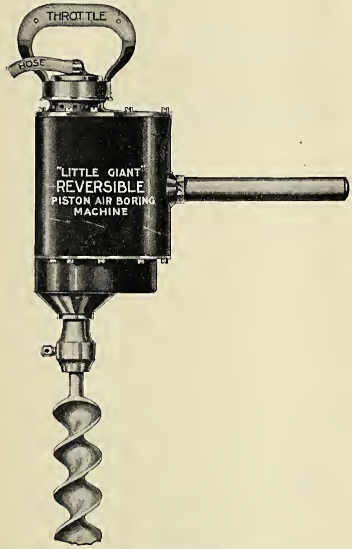
RACINE GENERATING SET.

Pneumatic Reversible Boring Machine.

A new portable tool known as the "Little Giant" pneumatic reversible boring machine has been brought out by the Standard Pneumatic Tool Co., Marquette Building, Chicago. This is similar in construction to the regular No. 2 boring machine of this Company, but possesses in addition a means of reversing the direction of the boring bit or augur when the machine is running at full speed. This is accomplished, so far as the operator is concerned, by the simple turning of a small lever, and it permits of the ready withdrawal of the augur. No gears are used in connection with the reversible attachment. For this machine, the makers claim advantages of light weight, compactness, and economy in the use of air. It is so fashioned as to be easily operated very close to a corner, and is especially adapted for use in shipyards, dock construction, and other places where much heavy work is to be done. The machines are sent on trial and guaranteed against repair for a year.

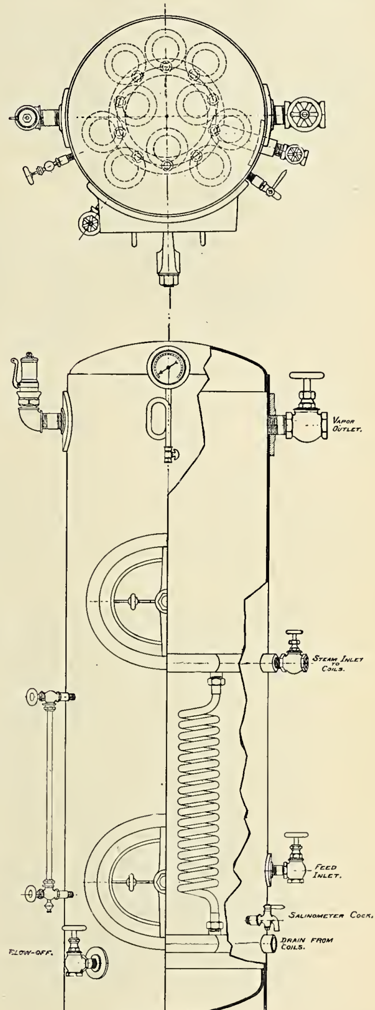
Quiggin's Patent Evaporator.

The necessity of having aboard sea going vessels the means whereby fresh water can be produced, was demonstrated during the late war with Spain, when many vessels were suddenly called away to ports where fresh water was a scarcity. An exaporating plant aboard a vessel greatly increases the vessel's radius of action. The Quiggin's patent evaporator, illustrated here, has met with marked success since its introduction in the marine trade. It has been fitted in some of the largest American transatlantic lines and in many coastwise vessels, yachts and also in the U. S. Revenue Cutter Service. It has been exceedingly popular in England for many years and has been widely adopted by the British Admiralty, and many of the leading lines. Special fea-



PNEUMATIC REVERSIBLE BORER.

tures which recommend it to the marine engineer are its lightness and its ready accessibility for cleaning. It requires no additional space for withdrawing heavy nests of coils for scaling and it also possesses the peculiar feature of making it possible to increase the capacity or heating surface by adding additional coils without taking up additional space or disturbing the apparatus in the ship. The shells are of boiler steel and have two manholes. The heating surface consists of annular-shaped composition manifolds having ground joint union connections for engaging the spiral coils. These coils are made of seamless copper tubing 7-8 in O. D. and will stand a pressure of 1,000 lbs. to the sq. in. They are grooved after coiling up in such a manner as to indent the surface and make a crescent-shaped tube the whole length of the coil. The special feature in this grooving is that the coil expands in two directions, and any scale which may be formed on the coil is quickly broken off. The ground joint unions on the ends of the coil are all interchangeable and made to a gauge. Besides being used in the marine trade,



QUIGGIN'S EVAPORATOR.

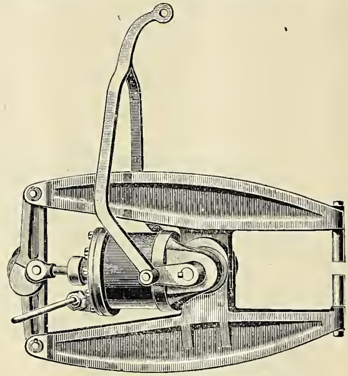
these evaporators have been employed on shore in ice-making plants, etc., for producing fresh water. They are manufactured by the James Reilly Repair & Supply Co., of 229-230 West street, New York city.

Portable Alligator Riveters.

Riveters of the squeezer type which operate by direct pressure and not by a succession of light hammer blows are built by the Bethlehem Foundry and Machine Co., of South Bethlehem, Pa. A good example of this type of riveter is shown in the engraving herewith of the portable alligator riveter, operated by compressed air, which is made by this company. This riveter is 5 ft. long, weighs 1,500 lbs., and has 20 in. reach at the center of the jaw and 3 1-2 in. stroke of dolly bar. The pressure cylinder is 12 in. dia. and 9 in. stroke. With the exception of the cylinder and a few minor parts the machine is made of steel castings and forgings, and is well balanced, easily handled, and is guaranteed to drive any size of rivet in common use. With a gang of four boys a record of 3,000 3-4 in. rivets in ten hours is claimed for this machine, the conditions being favorable for speed. Air pressure of 60 to 80 lbs. is usually employed with this machine, about 5 cu. ft. of free air being required for each rivet driven. At a speed of 3,000 rivets a day of ten hours, 15,000 cu. ft. of free air would be required. The makers figure that allowing for loss by leakage, etc., about 20,000 to 25,000 cu. ft. of free air would be necessary, and on this basis 40 cu. ft. of free air per minute would be required. Assuming one horse power to be capable of reducing 5 cu. ft. of free air per minute to a pressure of 75 lbs. per sq. in., the service would call for 8 horse power at the compressor.

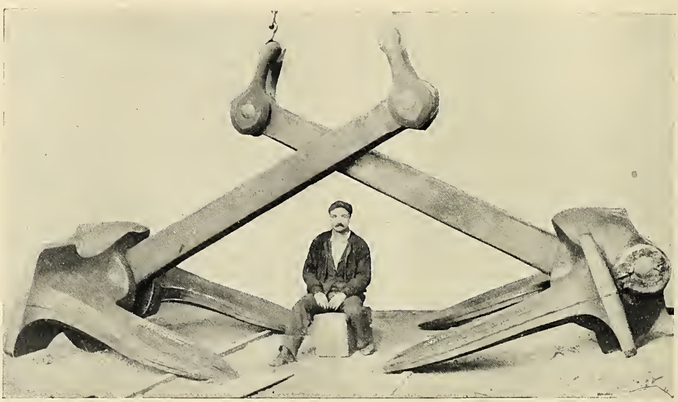
Baldt Stockless Anchors.

A comparison between the size of the man and that of the anchors in the accompanying reproduction of a photograph will convey an idea of their actual size. These two anchors were manufactured by the Baldt Anchor Co., of Chester, Pa., for the equipment of the U. S. Army transport *Thomas* engaged in carrying troops to Manila. The pair weigh 27,000 lbs., and are the largest stockless anchors ever made in this country. On October 11 the order for these anchors was placed by the Government through the James Reilly Repair and Supply Co., of New York, and work was so rushed that they were turned out at the steel works on October 28, and were put aboard the transport at Brooklyn, November 1 last. Open hearth steel, 60,000 to



PORTABLE ALLIGATOR RIVETER.

70,000 lbs. T.S., with elongation 15 to 25 per cent in 8 in., is the material used. Severe physical and chemical tests were also imposed. This type of anchor has been approved by Lloyd's Register, the Bureau Veritas, and is in use on naval vessels.



BALDT STOCKLESS ANCHORS FOR U. S. TRANSPORT THOMAS.

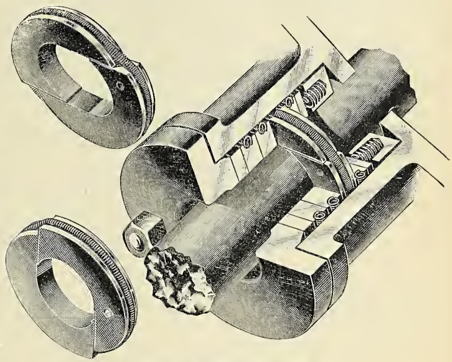
Harthan's Metallic Packing.

"Use good judgment and a little cylinder oil" are the directions for applying Harthan's metallic rod packing given by the manufacturers. This is a genuine metallic packing which has been in use for a considerable time on land engines and has recently been adapted for use on board ship. It is designed so that it will fit any fiber-packed stuffing box, and it can be put in place or

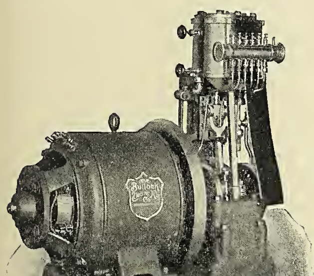
removed without disconnecting the rod from the cross-head. As shown in the engraving printed herewith the packing does not project down below the usual depth of the stuffing box and gland. The split rings are made of a special composition that will not run when an engine is working and at the same time is not sufficiently hard to score the rods, and these rings are held in place by coil springs. This packing can also be readily applied to valve rods. It is manufactured by the Reeves Machine Co., Trenton, N. J.

Bullock Generator—Forbes Engine.

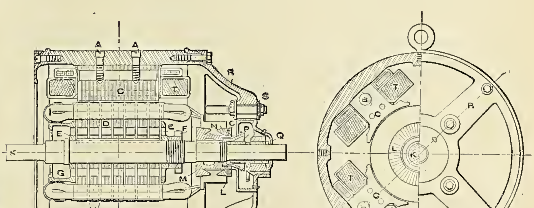
The combination electric generating set illustrated in perspective here consists of a Bullock type of generator direct connected to a Forbes marine engine. The engine cylinder is 5 in. by 5 in., built for high pressure steam. The cylinder is supported upon steel legs fastened to a subbase common to both engine and generator. To two of these supports the cross-head guide is securely bolted. Means are provided to adjust for wear of the cross-head shoe and guide and in the main bearings. A perfect system of sight feed lubricators is installed with copper tubes leading to all of the wearing surfaces of the engine. A small balance wheel is provided and assists in the regulation of the engine speed. The governor is of the inertia-centrifugal type and maintains a speed between no load and all load limits of less than two per cent variation. The valve is of the cylindrical balanced type and gives a perfect steam distribution. The generator is very compact, pleasing in outline and presents some interesting features of design as will be seen by consulting the sectional engraving. The yoke is a steel casting of circular form having inwardly projecting pole pieces of laminated soft steel. Each pole is bolted to the frame by two bolts *A-A*, the centrally located rivet *B*, of the laminated pole *C*, being tapped and serving as a nut for the bolts. The armature core *D* is built up of laminated soft steel mounted directly upon the shaft and held firmly together by iron end plates *E* and nuts *F* as shown, one end plate resting against shoulder *G*. Ventilating slots *H* perpendicular to the shaft are provided. The windings *I* are perfectly insulated before being placed in the slots of the core. The windings are held in place by steel wire bands wound in slots making a flush finish with the outside of the laminated core. The armature shaft rests in a phosphor bronze bearing at the outer end and is keyseated in the hub of the engine fly wheel. The commutator bars, shown at *L*, are held together by sleeve *M*, ring *N* and nut *O*. Oil shield *P* prevents oil from finding its way from bearing *Q* into the armature. The bearing *Q* is of the self-oiling type as shown. The end housing *R*, securely bolted to the frame, carries the brush studs *S*. The field coils *T* are machine wound and thoroughly insulated. The engine operates at 600 R.P.M. and at this speed the capacity of the generator is 5 K.W. at 115 volts pressure. This particular set is now installed upon the steamer *Aberdeen*, a vessel recently built for the Pacific coast trade. The manufacturers are the Bullock Electric Manufacturing Co., Cincinnati, Ohio. They make a full line of sizes of these engine type generators, and have also gone extensively into the equipment of machine tools with electric motors for direct driving.



HARTHAN'S METALLIC PACKING.



BULLOCK GENERATOR—FORBES ENGINE.



SECTIONAL VIEW BULLOCK GENERATOR.

MARINE ENGINEERING

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BY the time the reader has come to these pages he will have observed that this issue contains a very complete report of the proceedings of the seventh general meeting of the Society of Naval Architects and Marine Engineers, held last month in New York. From a business point of view the Society is in a very progressive condition, without debts, with a safe balance in the bank, and with a large and very rapidly increasing membership. That the financial conditions are so good bespeaks good management, for, as pointed out by President Griscom in his annual address, the dues are less than those of kindred societies. From a technical standpoint, the conditions were quite as satisfactory. The high grade of work demanded by the Society was well sustained in the papers read and discussed. The meeting did not, of course, take place without some criticism, and this was chiefly in the shape of expressions that naval matters were given attention largely to the exclusion of the mercantile marine. We believe that a fair examination of the programme will not support this criticism, for out of a total of fourteen papers, six were of as great, if not greater, importance to mercantile than to naval needs; while of the remaining eight, two papers (water-tube boiler and electrical equipment) while written entirely from naval standpoints, yet contained much that would be applicable to merchant marine practice or at least to a solution of pressing questions in that practice. In the matter of discussion, if naval men, by reason of their training and their freedom from the restrictions imposed by "trade secrets," have a preponderant share in the proceedings, it is the fault wholly and solely of the representatives of the merchant marine. Discussion from any competent person is not only welcomed but sought, and can be taken part in not only on the floor but by written communication. As a matter of fact, on several occasions while certain forms of apparatus were under discussion, well known makers of like apparatus were in the auditorium, but took no part in the debate. In this connection, too, many of the steamship owners who are members could add materially to the value of the transactions by permitting their superintending engineers to give facts and figures concerning operation, for all construction is toward the end of satisfactory operation. Speaking of discussion recalls the very pointed reply made by Engineer-in-Chief George W. Melville to the paper on the *Denver* class of cruisers prepared by Chief Constructor Philip Hichborn. Abstracts of both will be found in the preceding pages, so that we need not repeat their substance here. Reading over the Chief Constructor's paper it would not occur to us that any criticism of the neighboring Bureau of Engineering was intended, but whether or no the explanation by the Engineer-in-Chief of the causes for the *Raleigh's* trouble ought to set matters straight in all minds. It is somewhat curious to note that while the Engineer-in-Chief takes pains to explain at length the reasons for the *Raleigh's* inefficiency, with a view manifestly to shutting off unfair and outside criticism, he takes the Chief Constructor to task for defending the *Denver* designs from hostile criticism. That the design was adopted only after very careful consideration by the Board of Construction is to be expected, but that the naval experts ought to know the needs of the service and know better how to fill them than outside critics, is a statement not so readily agreed with. In the first place the needs of the navy are a matter of opinion largely, and find expression in the extreme, in the torpedo crank, the ram crank, the submarine boat crank and so on. Again there are subdivisions of enthusiasts. Take the torpedo boat, one wants it large, another small, one comparatively slow, another very fast, and so on.

Now it is reasonable to suppose that all opinions and all avenues of knowledge are not confined to the commissioned ranks of the navy, and that an outside expert by reason of his qualifications or experiences might have possession of one or two practical ideas. But aside from expertness is the liberty of speech and expression of thought, which is the inherent right of every American and the duty of those who hold the public ear, and which we believe would find no more earnest champion than the Engineer-in-Chief. And when such expression is given credence to by a wide audience, such as readers of the public press, it seems a very proper proceeding for those responsible to the people to give forth their reasons for expending the public money in ways which have been the subject of such criticism. This the Chief Constructor has done, and his arguments are convincing. We shall have six vessels, which in every respect will be a credit, alike, to all the responsible Bureaus, and which will not be white lies, but will carry the distinctive American color anywhere, at any time, at the designed speed.

FROM present indications it seems probable that the Naval shipbuilding programme which will be presented to Congress for consideration will be by no means an extravagant one. Indeed, considering the increased need for an effective naval force, which recent stirring events has brought about, and the efforts of other nations in the direction of sea power, it is a serious question whether our naval forces, present and prospective, are not inadequate. This is, however, a country governed by the people, and the development of our naval power is more dependent upon a proper knowledge of naval needs by the people than is the case with other nations of the first class. Abroad, the opinion of the "powers that be" on such matters is more generally accepted as conclusive by their countrymen than here. There seems to be a widespread belief here that at any time a powerful emergency navy could be improvised that would sail out and capture or destroy any hostile fleet. To this belief many of the uninformed though well intentioned voters are close adherents. Going a little higher in the scale of knowledge of naval affairs, many will be found who while they do not believe that tugs, yachts and coasting vessels can be converted into efficient battleships and the like, yet look to native genius, the abundance of materials, and expeditious American mechanical methods to pull us out of a hole in time of need. The first named class found their belief on such exploits as that performed by the converted yacht *Gloucester* at Santiago, and the others go back to the Civil War period of rapid construction, with Ericsson as their patron saint. Probably no one regrets more than those in authority that the modern warship is a box of complications fearfully and wonderfully made, but it is so, and so long as we have to encounter vessels of other nations so equipped we shall have to keep up or suffer the consequences. That certain modifications of existing designs are possible, which would result in simplicity, with even a gain in efficiency, is beyond question, but that is quite aside from the absurdity of "Emergency Construction." But to return to the forthcoming programme it is some satisfaction to note that it contemplates the construction of up-to-date and immediately useful types. In substance the programme is as follows:

Three armored cruisers of about 13,000 tons trial displacement: Maximum draft, 26 ft.: Heavily armored and armed: Sheathed and coppered: With the highest "practicable" speed, and great radius of action.

Three protected cruisers of about 8,000 tons displacement, carrying a powerful battery: Sheathed and coppered also: To have the highest "practicable" speed and great radius of action. These vessels were recommended for a place on the previous programme.

Twelve gunboats of about 900 tons trial displacement: Sheathed and coppered. These vessels are intended for shallow river service in foreign stations, and are of a type recommended by Admiral Dewey.

Meanwhile a start has been made toward the construction of the cruisers of the *Denver* class, contracts for their construction having been awarded as follows:

U. S. S. *Chattanooga*, Lewis Nixon, Crescent Shipyard, Elizabethport, to be built, in 30 months, for $1,039,966.

U. S. S. *Cleveland*, Bath Iron Works, Bath, Me., to be built, in 30 months, for $1,041,650.

U. S. S. *Denver*, Neafie & Levy, Philadelphia, Pa., to be built, in 30 months, for $1,080,000.

U. S. S. *Des Moines*, Fore River Engine Company, Weymouth, Mass., to be built, in 30 months, for $1,065,000.

U. S. S. *Galveston*, W. R. Trigg Co., Richmond, Va., to be built, in 24 months, for $1,027,000.

U. S. S. *Tacoma*, Union Iron Works, San Francisco, to be built, in 27 months, for $1,041,900.

These vessels have been described in detail in a former issue.

LOSS OF THE U. S. S. CHARLESTON AND BURNING OF THE S. S. PATRIA AT SEA.

To report the loss of an American war vessel is not as agreeable a task as to chronicle the launch of a new vessel, and especially is this so when the loss is an inglorious one, practically in time of peace. As our readers are aware from press reports, the U. S. S. *Charleston* was wrecked on an uncharted reef off the northeast coast of Luzon, Philippine Islands, early in November, and all on board were saved. The *Charleston* was engaged in patrol duty, and while steaming along the coast struck on the reef about 6 o'clock in the morning. It was soon seen that she was fast and would probably become a total loss, and it is likely that only the prompt closing of the water-tight doors prevented her sinking immediately. A heavy sea was on and the vessel was in danger of being washed off into deep water, so that it was decided to abandon her. The boats were provisioned with ten days' rations, and the crew got away carrying their rifles and the two automatic guns. A landing was made on a small island not far distant, and the day following a landing was made on Kamiguin Island, about ten miles distant. It was expected that hostile natives would be met, but, instead, the inhabitants made no disturbance. After waiting for the weather to moderate, a sailboat was sent off in charge of Lt. John D. McDonald, to proceed toward Manila and notify any passing vessel. After some rough weather experiences, the boat's crew sighted the transport *Aztec* in the Lingayen Gulf, November 11, and was towed to the U. S. S. *Oregon*, which was in the vicinity. Her commander at once ordered the gunboat *Helena* to proceed to the relief of the shipwrecked crew of the *Charleston*. In going ashore the *Charleston* appears to have run on a steep bank, as she was almost submerged at the stern, while the bow was high out of the water. Wreckers from Hong Kong will examine the vessel, with a view to salvage.

On the next page a view of the *Charleston* in her peace clothes is given. She was an unarmored steel vessel, being classed as a protected cruiser. She was one of the early ships of the new navy, and, as was the case with several other vessels, her plans were originated in England. She was built by the Union Iron Works at San Francisco, being launched in July 1888, and was first put in commission in December, 1889. Her chief characteristics were as follows: Length, on load line, 312 ft. 7 in.; beam, extreme, 46 ft. 2 in.; draft, mean, 18 ft. 7 in.; displacement, 3,730 tons; indicated horse power, 6,660; speed, on trial, 18.20 knots; bunker capacity, 750 tons; steaming radius at 10-knot speed, 4,256 knots. She was fitted with twin screws, driven by horizontal compound engines, and with Scotch boilers. For defense she had a protective deck, of a maximum thickness of 3 in. Her armament included two 8-in. breechloaders, one forward and one aft; three 6-in. breechloaders on each side, and four six-pounders, two three-pounders and two one-pounders, all rapid-fire, and the usual machine guns. She had one large funnel and two military masts. Her complement was twenty officers and 289 men.

Fire destroyed the Hamburg-American liner *Patria* while on her eastward voyage from New York to Hamburg, November 15. The fire is supposed to have been started in one of the holds by spontaneous combustion, and to have been smoldering for a considerable time before the smoke and flames made it known to the passengers and crew. It broke out fiercely one morning about 10 o'clock, when the vessel was in the English Channel. Fortunately the weather was calm and the boats, containing all of the passengers, were lowered without special difficulty. The Russian steamer *Ceres* shortly after came up and took on board the passengers, carrying them to Dover. The Captain and a portion of the crew remained with the vessel, but finally abandoned her, and she stranded on the coast of Kent, apparently a total wreck. The *Patria* was one of a fine class of twin screw vessels in the regular New York-Hamburg passenger and freight service. She was built at Stettin in 1894, and was of these dimensions: Length, 460 ft.; beam, 52 ft.; depth, 31 ft. 6 in.; gross tonnage, 6,664 tons. She was fitted with twin screws and triple expansion engines, and had all the fittings and appliances of the modern liner. She had accommodations for fifty cabin and a large number of steerage passengers.

Through the courtesy of a subscriber at Cambridge, Mass., we are able to publish a reproduction of a photograph of the Warren liner *Bay State*, the loss of which was reported in our last issue. She was a fine new twin screw vessel, of 6,824 tons gross, built in 1898 by Harland & Wolff, Belfast. Her dimensions were; Length, 490 ft.; beam, 52 ft.; depth, 32 ft. Her home port was Liverpool, England. She was fitted with triple expansion engines and return tube boilers constructed at the builders' yard.

CORRESPONDENCE DEPARTMENT.

Three-wire System of Electric Lighting.

Editor of Marine Engineering:

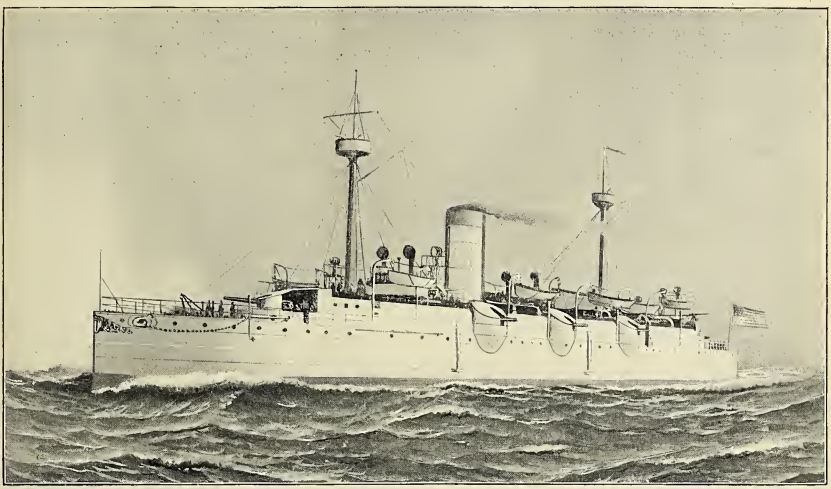
I wish to call your attention to the fact that the method of operating a three-wire system from a single four-pole machine proposed by Mr. Cecil P. Poole in your last issue is not new and as described is utterly inoperative.

With a machine connected up as shown in Fig. 4, the pressure will be equally distributed as stated when there is no load. The effect of a load either on the outer wires or from either outer to neutral is to concentrate the field under the trailing poles, that is, under the last pole of each sign under which the armature conductors pass. Thus under load the pressure under the first pole of each sign would fall to perhaps 75 volts, while under the following poles of each sign it would increase to 175 volts or over, or exactly as much as it decreased under the first-named poles. The two neutral brushes would thus, as shown, be in parallel with a difference of potential of, say, 50 volts between them, and would promptly burn up and the whole machine "lay down."

This is not a prediction, but an exact statement of fact as set forth in several articles in the electrical papers describing tests of machines arranged for working on my multi-voltage systems.

It is possible, by using but one neutral brush and complex balancing field windings to operate a three-wire system and I have a machine in my shop that I have operated in that way, but it proved so difficult to build and to adjust that I let it drop.

(*Continued on page 280.*)



U. S. PROTECTED CRUISER CHARLESTON, 3,700 TONS. WRECKED ON NORTHERN COAST OF LUZON, P. I.

HAM.-AMER. S. S. PATRIA, BURNED IN ENGLISH CHANNEL.

WARREN LINE S. S. BAY STATE, LOST NEAR CAPE RACE.

It would seem to be your duty to point out the error in your article or describe the methods now in use to accomplish the end desired. I would refer you to the Westinghouse dynamos in the lighting plant of the new Union Ry. station at Boston. The machines are quite different from that described by Mr. Poole and cannot be used where the voltage on each side of the neutral must be independently adjusted. The machines were recently described in the electrical papers. (*El. Engineer*, Nov. 11, 1898.) S. W. RUSHMORE,
Jersey City, N. J.

REPLY.

Replying to the letter above, the writer wishes to point out that nowhere in the article under discussion was any claim made for originality. The editor of MARINE ENGINEERING will recall a conversation in which the writer stated distinctly that the idea is old and that machines based upon this idea had been used in England years ago, though to a limited extent. These two statements effectively answer Mr. Rushmore's rather impetuous denunciation so far as statements go.

As to demonstration, Mr. Rushmore's offered explanation of his own failure to succeed, reminds the writer strongly of the small boy who concluded that a certain physical feat was impossible, because he had tried it vainly. (Not the slightest discourteous intimation is intended.) Mr. Rushmore's statement that most of the total field of two entirely separate pole-pieces will be concentrated under one of them by armature reaction is very rash. That the armature reaction of a modern dynamo will be so enormous as to force any magnetic lines backward out of one core into the next one is an absurd proposition. That the lines will concentrate under the trailing edges of *each* pole-piece is indisputable, but that fact proves none of Mr. Rushmore's claims.

Referring to Fig. 1 herewith, Mr. Rushmore will probably recognize a device used to prevent the congestion of lines under the trailing edges, *t*, *t*. That such a device gives a reasonably stable field no one will deny. Experiments with a machine so built have shown that a third brush can be applied at *m* without

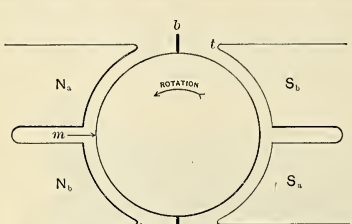


FIG. 1.

sparking, but two midway brushes cannot be used because the halves *Nb* and *Sa* are of unequal strength, producing the result described by Mr. Rushmore. In this case *one coil* supplies both *Na* and *Nb*, so that the armature reaction can unbalance the two halves up to the point where *Nb* becomes saturated. But this is a totally different case from the one in question, though Mr. Rushmore has misapplied the reasoning for this case to the other one.

In Fig. 2, N_1 and S_2 will be of equal strength if their excitation be equal. The armature reaction from — to *n* will be exactly equal to that from — to *n'*, hence each field will be distorted alike, and all of the brushes will require to be moved the same distance from the

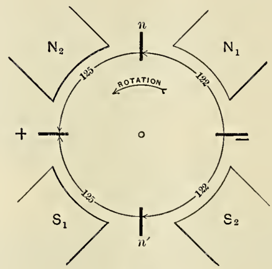


FIG. 2.

theoretical commutating points, which is equivalent to not moving any of them, so far as their inter-relations are affected. Similarly, N_2 and S_1 will be equal in strength, under equal excitation, no matter what (within practical limits) may be the difference between N_1 and N_2, and correspondingly, between S_1 and S_2. The diagram shows a difference of potential between + and *n*, *n'*, of 125 volts, and a difference of 122 volts between — and *n*, *n'*. Will Mr. Rushmore kindly say how *n* and *n'* can be at different potentials either above — or below +? He will probably argue that the potential difference between — and *n* is lower than that between — and *n'*. For this to be true, the armature reaction under N_1 would have to force part of the lines of force created by the coil on that pole to leave it and appear under the pole N_2. In the name of common sense how is such a performance possible?

I have argued the case merely in order to show the fallacy of Mr. Rushmore's reasoning. The whole question might have been disposed of with the simple statement, which can be substantiated, that machines of the sort described have been built and operated without showing the least tendency to "lay down" or manifesting any disquieting symptoms. If Mr. Rushmore would like a design for such a machine, to be "utterly" operative, he can easily obtain it.

CECIL P. POOLE,
New York.

The Hamburg-American Line has repurchased the S.S. *Columbia*, which it sold to Spain before the Spanish-American war, the vessel being then renamed the *Patriota*. The *Columbia* has again taken her place in the express service of the company to New York.

The British Admiralty is experiencing much difficulty in recruiting a sufficient number of machinists, who in that service are styled artificers. Special efforts are to be made to induce skilled mechanics to join.

ENGINEERS' DICTIONARY.—XXII.

Fig. 80.

Hydrometer—In general an instrument for determining the density of a liquid relative to that of some standard, such as water. In particular an instrument for determining the density of the water in a boiler relative to fresh water. The name *salinometer* is often used in referring to this particular form of hydrometer. As shown in Fig. 80, it consists of two bulbs with a stem above. The lower bulb is weighted with shot in order to keep the instrument upright in the water, while the stem is provided with one or more scales for reading the density according to the depth to which it sinks in the water. Ordinary sea-water has about one part in thirty two of solid matter, and the scale is usually marked so that in sea-water the instrument will sink to the mark 1, in water having twice the relative amount of solid matter to mark 2, etc. The reading on the scale then shows the number of parts of solid matter in thirty-two of water. As the reading would depend somewhat on the temperature also, it is customary to provide three scales, one arranged for 210°, one for 200°, and one for 190°. The water being drawn from the boiler rapidly cools down through these temperatures, and at one or more of them the desired test may be made.

Hydraulic Test—A pressure test applied to boilers or other closed chambers, in which water is forced by a pump into the boiler or chamber until it is full and the pressure has risen to the desired point. The test pressure for boilers is usually one and one-half times the working pressure.

Indicated Horse Power—The power developed by the steam or other working fluid in the cylinders of an engine. This power is computed from the indicator cards, and is usually denoted by the initials I. H. P. See under Horse-Power.

Indicated Thrust—As explained under Horse-Power, work is measured by the product of force by distance or motion, while horse-power is measured by the work done per minute of time. Indicated horse-power may therefore be considered as the product of a certain thrust or force multiplied by the distance through which the ship is moved per minute. Such a force is called the *indicated thrust*. It is, therefore, equal to the indicated horse-power reduced to foot-pounds and divided by the speed of the ship in feet per minute. If there were no loss of power by friction in the engine, and if the propulsive action of the propeller caused no loss of power, the actual thrust at the thrust block would be the same as the indicated thrust. In the actual fact there is necessarily loss in both these ways, and the indicated thrust is therefore greater than the actual thrust in the ratio in which the indicated horse-power is greater than the thrust horse-power. The rule for finding indicated thrust is, therefore, as follows: *Rule*—Multiply the I. H. P. by 33,000 and divide by 101.3 times the speed in knots, or by 88 times the speed in miles per hour. This will give the indicated thrust in pounds, after which it may be reduced to tons by dividing by 2,240 or 2,000, as may be desired. Example: I. H. P. = 1,800, speed = 13 knots. Indicated thrust = $(1{,}800 \times 33{,}000) \div 13 \times 101.3 = 45{,}100$ lbs. = 20.1 tons.

Indicator Card—The card or diagram obtained by means of the indicator. A typical card is shown in Fig. 81. *A* is the beginning of the stroke, *B* the point of cut-off, *C* the point of exhaust opening, *D* the end of the stroke and beginning of the return, *E* the point of exhaust closure, and *F* the point of steam opening for the next stroke. *AB* is called the *steam* line, *BC* the *expansion* line, *CDE* the *exhaust* line, *EF* the *compression* line, and *FA* the *admission* line. The line *PQ*, drawn

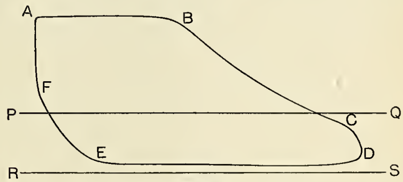


Fig. 81.

when the space below the indicator piston is shut off from the engine cylinder and connected to the air, is called the *atmospheric* line. A line *RS*, drawn parallel to *PQ* and at a distance below it, representing to the scale of the diagram the atmospheric pressure, or 14.7 lbs. per square inch, is called the *absolute pressure* line. The distances from this line to *ABCD* give the value of the total forward pressure at various points of the stroke, while similarly the distances from *RS* to *DEF* show the values of the back pressure at similar points. The area of the diagram divided by its length will give the mean height, and this, multiplied by the scale of the spring, will give the *mean effective pressure* for the stroke. A similar diagram from the other end of the cylinder will give like information for that end, and the mean for the entire revolution may thus be found. The use of this in computing power has been described under Horse-Power.

Indicator Cock—A form of cock for connecting the indicator with that end of the cylinder from which the card is desired. Where an indicator is provided for each end of the cylinder, a *two-way* cock is required for connecting the indicator with the air or with the cylinder, as desired. Where but one indicator is provided for both ends of the cylinder a *three-way* cock is required for connecting the indicator with the air or with either end of the cylinder, as desired.

Indicator Connections—A general term relating to the piping and fittings connecting the indicator with the cylinder.

Indicator Motion—A general term relating to the gear used for giving motion to the indicator drum.

Two 20-knot cruisers are now under construction at the Bergsund Works, Stockholm, for the Swedish Government, and a battleship, the *Dristigheten*, is also being constructed at Lindhlomen, Gothenburg. These vessels are to be fitted with water-tube boilers of the Yarrow type.

NEW PUBLICATIONS.

Problems in Machine Design. By Charles H. Innes, M.A., Engineering Lecturer at the Rutherford College, Newcastle-on-Tyne. Second Edition, 1899. Technical Publishing Co., Manchester, England. Size, 5 by 7 1-2. Pages, 258. With 200 diagrams. Cloth, 4s. 6d.

This book has been especially prepared as an aid to the student for the honors stages of the British Science and Art and Technological Examinations in Machine Construction and Mechanical Engineering. It is, therefore, concerned with the broad field of structural machine design with more especial reference to the chief elements which enter into machines and engineering works, rather than with the design of complete machines, which, according to the author's preface, he hopes to deal with at a later time in a separate volume.

The book is divided into twenty-two chapters, each one dealing separately with some one sub-division of the subject. The first few chapters are introductory in their character, and deal to a considerable extent with graphical statics and other principles of mechanics which are required for treating the subject. In Chapter IV some of the more complex forms of riveted joints are discussed, and illustrative examples are worked out showing their relations to the rules of the *British Board of Trade*. Cottered joints, connecting-rods, piston-rods and shafting, occupy the following ten chapters. These chapters are to be especially commended for the clear way in which the subject matter is presented, for the close connection which the author makes between actual practice and the formulæ given, and for the large amount of data given in tabular form and furnishing a series of illustrative values for the leading dimensions of these features, drawn from both British and American practice.

The following chapter deals with expansion valve gears, in which the leading types of gear are explained and discussed by the aid of the Zeuner, Reuleaux and elliptical diagrams. This chapter is perhaps open to some criticism by reason of the too great reliance which seems to be placed on the diagrams, and on purely analytical investigation. Few valve gears can be designed in a thoroughly satisfactory manner without the aid of a model or of some method for obtaining point by point the actual motion of the valve relative to the piston, including all secondary causes of disturbance. The use of simple diagrams alone must always be considered as a first approximation only, and the attempt to deal with secondary disturbances by analytical methods is entirely too cumbersome to admit of application in a drawing office. The marine engineer will also note the absence of all reference to the Walschaert gear, a form of valve-gear which is attracting some attention in the marine field at the present time.

In the following chapter the subject of inertia forces and balancing is taken up. This chapter is less satisfactory than several of those which precede, partly because the author in his efforts at condensation has omitted all fundamental explanation and introduces trigonometric equations and other results without a word of explanation as to their derivation or significance. This entire chapter is written in too condensed a style for the average student, and it is doubtful if those who are not already familiar with the subject could gain much additional idea from the presentation here given. A word of caution relative to the attention which this subject is at present receiving may properly be noted at this point. It must not be forgotten that it is quite possible to overestimate the relative importance of balancing, and to overdo the matter, especially if the system leads to serious changes in the accepted and customary crank angles and other features. In no case with the moving parts all on one side of the shaft can the balance be perfect, and in the opinion of the reviewer all significant balance may be obtained by an appropriate adjustment of crank sequence, cylinder sequence, and valve movement relative to piston, with, of course, aid from the adjustment of weights of moving parts when convenient.

Following are chapters on governors and on the design of spiral springs. In these chapters the subject is discussed in more detail, and the treatment is more satisfactory.

The design of air vessels for pumping machinery is considered in the next chapter, a subject which is too often omitted from all consideration, both by the writers of books and by the builders of pumping machinery. The remaining chapters deal with fly-wheels and with the diagram factors and ideal cards of compound engines.

Taken as a whole the book contains very much of value to the student of machine design, both in the range of topics treated, and in the large amount of actual data given. Throughout the book, marine practice receives more attention than is usually given to it in works not especially relating to this field of design, and it will be of corresponding value and interest to the designer of marine machinery. The chief fault of the book lies in the style of the author, which is not always clear, and in an effort at condensation which has resulted in gaps which many students would fill in only with difficulty. It is true that the author expressly notes in his preface the omission of much of the elementary part of the subject, but it may be questioned if he has not thereby decreased the usefulness of his work for the average student who may not have a more elementary work at hand, or who may not know where to turn quickly to fill the gaps occurring in the present work.

The illustrations throughout the text are numerous, and for the most part well executed, though occasionally one is found which has suffered either in the reproduction or printing.

The Practical Engineer's Pocket Book for 1900, published by the Technical Publishing Company, Manchester, England, has been issued and is for sale by D. Van Nostrand Company, New York. This little annual contains a valuable amount of data for ready reference and is sold at a very low price, 1 shilling and 6 pence. It has been increased in size and in the number of subjects covered. It is chiefly intended for mechanical engineers and is, of course, written from the standpoint of British practice. It contains, however, much information indispensable to the marine engineer.

The series of papers on the Slide Rule written for the *American Machinist* by F. A. Halsey, has been published in book form by D. Van Nostrand Company, New York. Price, 50 cents.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

In answer to the query of "An Inquirer."

A.—When a ship is turning under the influence of the rudder the point on the ship about which the swinging motion takes place is usually well forward and near the bow. Hence a rudder located at the bow has a very much shorter arm or leverage than one at the stern, and it is due chiefly to this fact that a rudder at the bow is very much less effective than one at the stern. In faot, the bow is the very worst place at which a rudder can be located.

Due to this and other reasons it is customary in ferryboats to lock the forward rudder and use only the one at the stern. It thus results that two independent sets of steering appliances are fitted, each rudder being connected with the pilot house on the opposite end of the boat. The connection of each rudder to both wheels would result in a further complication of tiller ropes and leads which of itself would be quite undesirable.

In the case of the catamaran which you mention, it will be undoubtedly much better to follow the same plan, and to have the rudders independent, and so fitted that when going in either direction those at the bow may be locked, and those at the stern brought into use.

Q.—Please publish a rule for finding the collapsing pressure on a corrugated furnace. Is there any rule for finding what the length of furnace crowns should be? TEXAS.

A.—The U. S. rule for finding the safe working pressure on a corrugated furnace is as follows:

Rule.—Multiply the thickness in inches by 15,000 and divide by the mean diameter in inches,

$$\text{or Pressure} = \frac{15000\ T}{D}$$

This rule is based on experimental determinations of the collapsing strengths of corrugated furnaces, and is intended to give a factor of safety of from 5 to 5½. Hence, taking a fair value from the experimental results, we have the following rule for finding the pressure at which we should expect collapse:

Rule.—Multiply the thickness in inches by 80,000 and divide by the mean diameter in inches,

$$\text{or collapsing pressure} = \frac{80000\ T}{D}$$

Example.—Thickness = ½ in., mean diam. = 40 in., then the probable collapsing pressure would be not far from:

$$p = \frac{80000 \times 1}{40 \times 2} = 1000\ lbs.$$

With corrugated furnaces the length does not enter into the formula for strength, and so far as strength is concerned, there is no limit whatever on the length of furnace.

Q.—Will you please inform me as to when an engine will make the most revolutions—going with a strong tide or against it? A. D. P.

A.—There seems to be no reason to expect, with the same steam pressure, any marked difference in the revolutions, whether steaming with or aginst the tide. There are reasons, based on abstruse mathematical principles, for expecting a slight increase in revolutions when running in either direction in a tide-way as compared with the revolutions in absolutely still water.

Q.—Kindly explain what is meant by the "Russian method of vise work" which was used at the Naval Academy for the instruction of cadet engineers? OLD SUBSCRIBER.

A.—The so-called Russian system of vise work for manual training consisted of a carefully graded series of exercises, each involving some simple or elementary operation with hand tools, the whole intended as a training in the elements of vise and bench work. In such a system the exercises are done simply as an end in themselves, and they have no relation to any finished product, and are not intended to be of direct use in themselves, except as they afford an opportunity for training the muscles and eye of the student.

As illustrations of such exercise the following may be mentioned:

Chipping a small block of cast iron to a flat surface.
Chipping a groove or key way in such a block.
Filing up such a surface flat and true.
Filing up two surfaces at right angles to each other.
Filing up two surfaces parallel to each other.
Filing up two surfaces tapering by any given amount.

The name Russian was given to the system on account of the examples of work from a manual training school in St. Petersburgh, which were exhibited and attracted considerable attention in this country at the time of the Centennial Exposition of 1876.

Q.—In your October issue, I note the following statement in reference to a steam engine: "We must remember that it is the heat that really does the work and that the steam or water is only the carrier for it." Now take the following case: A is an old-fashioned plant, and where fuel is little or no object. When the boilers were first installed they were calculated for a pressure of 100 lb. per sq. in., but through old age the pressure has been reduced to 70 lbs. per sq. in., at which pressure the engines will not develop enough power to do the work required of them. Now if it is really the heat that does the work, could he not fit a superheater and heat the steam so that as many heat units will pass into the engine now at 70 lb. as there were formerly at 100 lb., and if so, will the engine do as much work as at the original pressure, and if not, why not? J. G. C.

A.—It is true that by superheating the steam at 70 lb. pressure, one pound weight of steam could be made to contain as much heat as one pound of ordinary steam at 100 lb. pressure. It would require only about 15 degrees of superheat to accomplish this. It is also true that such steam used in the *same engine* would not develop the work which would be given by ordinary steam at 100 lb. pressure with the same amount of heat per pound of weight. It is also true that it is the heat alone which does the work.

Now let us examine briefly the seeming contradiction.

In the first place the superheated steam at 70 lb. pressure would not give as much work in the *same engine* as ordinary steam at 100 lb. pressure, for the reason that it would be less dense, and hence the engine would take in a smaller *weight of steam* at each stroke. If the engine were of such size, for example, that at each stroke one pound weight of steam at 100 lb. pressure would enter, then only about .73 of one pound weight of the superheated steam at 70 lb. pressure would enter per stroke, and hence for this reason, if no other, less work would be done. To be fair to the superheated steam it would be necessary to give it a larger engine so that cutting off at the same point in each, the same weight of steam will be admitted per stroke. If this were done it would be found that the engine with the superheated steam at 70 lb. pressure would develop very nearly or perhaps quite as much work as the smaller engine using the same weight of ordinary steam at 100 lb. pressure.

But there is still another difference between the two sets of conditions which may effect the result. This is the difference in temperature. To appreciate the influence of this feature we must remember that while it is the heat alone which does the work, it is not only a question of how much heat the substance has when it comes to the engine, but also of how much of this heat can be transformed into work, and how much must be allowed to escape with the exhaust and in other ways. If we were able to make an exact heat balance we should find that the heat which is transformed into work plus the amount which escapes with the exhaust and in other ways will exactly equal the amount which comes into the engine. Now, it is clear that the greater the amount of heat which can be transformed into work, the better the efficiency of the engine. Usually this amount varies from 5 to 20 per cent. It follows that with a given amount of heat to start with, one engine may transform 5 per cent. into work, another

10 per cent., and another 20 per cent. Or with the same amount of heat to start with, one engine may give back twice, three times, or even four times and more the work of another, simply by reason of its higher efficiency.

In this case, therefore, the question is as follows: Of two engines each using the same weight of steam with the same heat per pound, one superheated and one ordinary steam, which will be able to make the better use of the heat—which will give back the larger return in the form of work? Without going into details it can be said that other circumstances being the same, the higher the initial temperature the better the efficiency, and the more work returned for the same amount of heat. On the other hand superheating tends to prevent a loss in the use of ordinary steam due to the condensation in the cylinders.

The ordinary steam in the question under discussion will have the advantage of a higher temperature, while the superheated steam will have the advantage of saving a part of the cylinder condensation. How the final result would balance off could only be determined by actual test, but in the case you describe the difference would certainly be very small.

In general it may be seen that heat is all that is used by considering the case of a condensing engine without leak or water wasted. In such an engine the same water would be used over and over again without loss, while the coal pile would need to be constantly renewed. *This shows that it is heat which is being expended and not water or steam.*

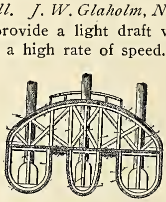
The same general principles are true no matter what the medium used, whether heated air in an air engine, or heated gas in a gas or vapor engine. It is heat, and heat alone from which we derive the work in all such forms of motor.

SELECTED PATENTS.

(Subscribers are notified that the publication of a patent specification in this column does not indicate editorial commendation or condemnation.)

634,814. Hull. J. W. Glaholm, Nanaimo, Canada.

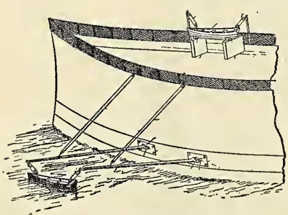
CLAIM.—To provide a light draft vessel capable of being driven at a high rate of speed. Hull is formed



in three parallel sections converging into a common bow. The deck is arched and merges with the outer sides of the outer hull sections.

634,028. Means for launching life-boats from vessels. James Pollitz and E. H. Cox, New York, N. Y.

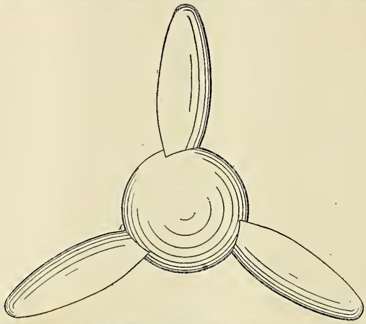
CLAIM.—The boats are supported over the deck of the vessel by long arms, which are hinged to the out-



side of the body of the vessel. When the arms are floated, the boat will be floated at a point beyond the wash of the vessel.

634,368. Screw-propeller. Thomas Pounds, Plymouth, England.

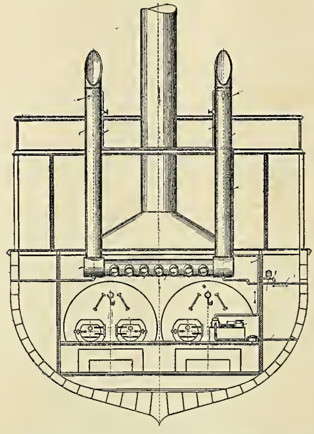
CLAIM.—To obviate the negative pressure due to the thickness of the blades, which is exerted upon the for-



ward faces of the blades near their leading edges. The driving-face is of uniform pitch from its following edge to where the blade is thickest; and of gradually increasing pitch from there to its leading edge.

634,563. Apparatus for ventilating and cooling stoke-holds of steamships. Max Robitschek, Vienna, Austria-Hungary, assignor of one-half to Leo Von Herz, same place.

CLAIM.—Water atomizers are so arranged in the upper parts of the usual ventilation shafts as to produce a downwardly-directed jet of spray, which sucks in the air from without and cools and moistens it by partial evaporation. The lower ends of the ventilator



shafts open into water separators having inclined bottoms and baffle plates, against which the current of air and spray impinges. These separators communicate with chambers arranged in the ceiling of the stoke-hole and provided with a number of outlets for the cooled air.

TRADE PUBLICATIONS.

The Chicago lubricator pump is concisely described in a six-page folder sent out by the manufacturers, the Phœnix Metal Packing Co., 177 La Salle street, Chicago, Ill. Brief mention is made of the many uses to which this pump is specially adapted in marine work.

A 300 page catalogue is sent free to all machinists and others by Charles H. Besly & Co., 10 North Canal street, Chicago, Ill., describing the great variety of tools and other specialties handled by this firm. The catalogue is very complete and thoroughly illustrated, making it one of much value for reference.

A neat four-page folder is issued by the International Correspondence Schools, P. O. Box 1111, Scranton, Pa., referring to three young men who recently secured excellent positions through the system of education of these schools. Young men seeking promotion should send for copies of these folders, together with full information.

"Valve Reseating Machines; Also Taper Reamers," is the title to a pocket size catalogue issued by C. F. Hall, Son & Co., Skaneateles, N. Y. The illustrations show different types of machines, such as those designed for gate and for globe valves, as well as for other uses. Many testimonials are also published and names of concerns and vessels where these machines are in use.

The Shepherd engine is fully illustrated in a catalogue just issued by the American Fire Engine Co., Seneca Falls, N. Y. The engine is designed by the inventor of the well-known governor of the same name, and is made for high speed and in small sizes, especially adapting it to small electric sets. The various types and sizes manufactured are shown in the illustrations and described in the text.

Engine and boiler supplies manufactured by the Sherwood Mfg. Co., 34 Washington street, Buffalo, N. Y., are fully described in a seventy-page catalogue. Most of the catalogue is devoted to the injectors of all types manufactured by this company. Lubricators also have many pages devoted to them. Other specialties are flue scrapers of various types, couplings, oil pumps, etc. Copies can be had by writing to the company and mentioning "Marine Engineering."

Generators and motors manufactured by the Onondaga Dynamo Co., Syracuse, N. Y., are completely described in a catalogue recently issued. The illustrations include the armature, separate and connected to the shaft; also the manner of winding, and complete pictures of the dynamo, both separate and direct-connected. These dynamos are made both "clover leaf" and ring type. In addition to the detailed description of this apparatus the catalogue contains a number of testimonials.

The subject of "mechanical thermometers" is treated exhaustively in a large and handsomely printed catalogue issued by the Hohman & Maurer Mfg. Co., Rochester, N. Y. These instruments are made in all designs from a simple registering of ordinary heat to the testing of the heat of gases in the stack, forced draft apparatus, and in short for any use where a close recording of the heat is necessary. This company's specialties also include a full line of barometers and gauges of all kinds.

Steam regulating devices and steam pumps manufactured by the Mason Regulator Co., 6 Oliver street, Boston, Mass., are very fully described and thoroughly illustrated in a very compact catalogue just issued. The catalogue comprises some forty pages and describes many specialties which will be of much interest to our readers, such as valves of many kinds, steam pumps of various types, etc. Copies of the catalogue can be had upon application and should be sent for by all interested, as this catalogue supersedes all previous ones.

Users of marine glasses should send for a copy of the catalogue issued by C. P. Goerz, 52 East Union Square, New York, descriptive of the Trieder binoculars. The catalogue is pocket size and contains over forty pages. Every one of our readers will want one of these catalogues because of the detailed description it gives of the great improvement in marine glasses that has been accomplished within a few years.

Pipe threading machines manufactured by D. Saunders' Sons, Yonkers, N. Y., have a very complete catalogue devoted to them. The size is 7 by 10 in., and it comprises 120 pages very fully illustrated and with ample descriptive reading matter. Many of the cuts are full page size, thus making the detail very complete. Besides the regular lines of machines there are special machines, together with tapping and drilling machines, hand stocks and dies, taps, reamers, wrenches, vises and a variety of other specialties specially designed for the use of steam fitters.

Gas engines, launches, boats and boat trimmings manufactured by the Gardner Motor Co., Ltd., New Orleans, La., are well described and illustrated in a catalogue just published. The introduction states that this motor is the development of six years of the closest attention to the subject of gas engines, making, it is claimed, one of the most simple, efficient and reliable engines on the market. Illustrations are given of the engine in various types and of its manner of being installed in launches and boats of various kinds. Several testimonials are also given.

The Racine engines manufactured by the Racine Hardware Co., Racine, Wis., are described in a very handsome catalogue of thirty-six pages and cover. The printing is on fine coated paper and the engravings are large and very numerous. The engines are described, not only as a whole, but in each part, the detail being very complete. Direct connected plants of several types are shown and there is quite a good deal of information on the subject of electric lighting. Small marine engines and water-tube boilers, making a compact marine set, are also shown in considerable detail.

The Westinghouse Junior engine has a very handsome catalogue devoted to it published by the Westinghouse Machine Co., Pittsburg, Pa. The catalogue is 7 by 9 in. in size, with very attractive cover and comprises thirty-six pages, with numerous engravings of the highest quality. The various parts of the engine are thoroughly illustrated, and there are also sectional views showing in full detail the working of this engine. The catalogue is one of the handsomest recently published. Among the most interesting parts of the catalogue to our readers will be the direct connected generating sets.

Users of small marine steam engines will want to send for a copy of the catalogue issued by the Rochester Machine Tool Works, Rochester, N. Y., describing the Acme engines and boilers. The smaller size of the combined engines and boilers manufactured by the works are adapted to burn oil or any other kind of fuel. For the larger plants the Buckley safety water-tube boiler is used. These marine sets range in size from 1 1-2 horse power upwards, and are made as compact and as complete as possible. Copies of this catalogue can be had upon application and by mentioning "Marine Engineering."

Motors for shop and other uses of the type manufactured by the Crocker-Wheeler Co., 39 Cortlandt street, New York, have a twenty-eight-page bulletin, 8 by 10 in. in size, devoted to them. The illustrations are large and excellent and there is a great deal of reading matter, making the description very complete. Many sectional drawings are also given, not only regarding the motor, but switch board connections, etc. Some attention is also given to brake motors. From the text it is evident that these motors can be adopted for almost any use for which motors are used, one type being enclosed.

Launches and other boats built by W. R. Osborn, Peekskill, N. Y., are briefly described in a folder which is now being distributed. Brief mention is also made of gas engines, boat fittings and other yachting specialties which Mr. Osborn handles.

A pocket size eight page catalogue is issued by the Knecht Bros. Co., 2442 Beekman street, Cincinnati, O., descriptive of a patent sensitive drill. A picture of the drill is given and much information regarding its capablites, type of construction, speed, etc.

The National automatic injector is concisely described and well illustrated in an eight-page folder issued by the manufacturers, the National Injector Co., 97 Woodland avenue, Cleveland, O. The folder also contains a number of testimonials, together with price lists and other information of value.

Interior telephones manufactured by the Acme Interior Telephone Co., 72 Trinity Place, New York, are adapted to all interior uses, such as steam vessels, warehouses, shipyards, etc., as described in a catalogue just issued. The telephone is illustrated and described and testimonials are given from many users.

"File Filosophy" is the title to a pamphlet issued some time ago by the Nicholson File Co., Providence, R. I., and which was so popular that it has become necessary to issue another edition. Containing as it does so much information regarding the subject of files and other tools it will be of much interest to our readers.

"Advertising Designs" is the title to an attractive pamphlet issued by the Trade Paper Advertising Agency, 150 Nassau street, New York. A large variety of advertisements are given specially designed by the artists of this agency. Those of our readers interested in the subject of designing advertisements will find the book well worth referring to.

The Mason pump governor has an exceptionally handsome catalogue devoted to it issued by the Mason Regulator Co., 6 Oliver street, Boston, Mass. The pages are large and of fine coated paper, and the printing is in two colors. The illustrations are excellent and of sufficient size to show in much detail the manner in which the governors are used.

Surface condensers, expansion joints and other Wainwright appliances manufactured by the Taunton Locomotive Mfg. Co., Taunton, Mass., have a very handsomely printed catalogue devoted to them which has just been issued. The illustrations and printing are excellent and the reading matter is unusually straightforward and business like. Particular attention is called to the Wainwright feed water heater.

Bipolar dynamos and motors and ventilating combinations have a special bulletin devoted to them issued by the C. & C. Electric Co., 143 Liberty street, New York. The motor is fully described, having several pages devoted to it and the type of ventilating fan referred to is also illustrated and described in considerable detail. Altogether the bulletin is one that many of our readers will find well worth sending for.

BUSINESS NOTES.

Brilliant Metal Polish.—Brilliant metal polish is put up in either liquid or paste form by its manufacturers, H. B. Leonard & Co., Somerset, Mass., with branch offices at 141 Milk street, Boston, Mass., and 131 Pearl street, New York. This polish does not contain acid, so it is claimed, and will resist damp, foggy air very successfully. It is already in use on many yachts along the New England coast.

Marine Electric Work.—Some very excellent testimonials are published by Thomas P. Benton & Son, La Crosse, Wis., regarding the use of their electric outfits for vessels, as this company furnishes not only the search lights but complete electric equipment. Among the testimonials is one from the president of the Diamond Joe line referring to Benton equipments saying that they have given perfect satisfaction.

Aluminum Coated Steel.—A new sheet metal designed to be superior to galvanized or other coated metals is being put on the market by the Steel & Iron Metal Coating Co., West Chicago, Ill., with an eastern office at 120 Liberty street, New York, in charge of J. C. Jessup. The claims for this metal is that the coating is firmly united to the base so that it will withstand heat and will not peel, that it will resist salt, acids and oils, and is rust proof. Circulars and other information regarding this metal can be had from either office.

Fine Boiler Works.—The Westinghouse Electric & Mfg. Co., Pittsburg, Pa., was awarded the contract for remodeling the marine boiler works of Wickes Bros., East Saginaw, Mich. All operations in the new shops are performed by electricity. Line shafting is run along both sides of the new works from end to end. This shafting is belted to small electric induction motors of 10 and 15 horse power each. From this shafting the small machines for drilling, punching, planing, cutting, etc., are belted. Above the shop is a traveling crane also worked electrically running from end to end of the works. There has also been installed a 130 horse power Westinghouse generator of 250 volts, belted to a steam engine. From this generator is furnished the power necessary for driving the machines. One peculiarity of the arrangement is that the line shafting is placed in sections, each section being driven by a small electric motor. This enables any section of the shop to be cut off from the power at any moment when work is not going on. Should any accident happen to one motor, arrangements have been made for coupling the sections of shafting together which will then be driven by another of the motors. It has been found that these arrangements have introduced considerable economy in the operating expenses as compared with the old method.

THE NICLAUSSE BOILERS.—The Niclausse water-tube boilers now building by the Stirling Co., Pullman building, Chicago, Ill., for the Russian cruiser and battleship and for the U. S. S. *Maine*, under construction at the works of William Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa., will aggregate 58,000 horse power.

PNEUMATIC TOOL TRADE.—The American Pneumatic Tool Company, of New York city, has sold to the National Pneumatic Tool Company, of Philadelphia, Pa., the right to manufacture pneumatic tools for use in the metal trades. The National company pays a considerable sum for this privilege, which is to be exclusive except as regards the American Pneumatic Tool Company. The latter company will continue to make and sell pneumatic tools for all purposes as heretofore.

A BUSY SHIPYARD.—The Harlan & Hollingsworth Co., Wilmington, Del., announces that it recently signed a contract to build a three deck steel vessel for the American coasting trade for the Metropolitan S. S. Co. The new vessel will be 289 ft. over all; 271 ft. between perpendiculars; 43 ft. beam, and 31 ft. depth to awning deck. She will have triple expansion engines, four Scotch boilers and all the latest improvements. This is the eleventh vessel now under construction in the yards of this company, and if all the ships under construction and contracted for were placed end to end they would extend nearly three-quarters of a mile in length.

MARINE PAINT.—Special attention is called to the Old Reliable submarine compositions for steel ships' bottoms which is manufactured by M. J. Williams, 77 South street, New York. Some of the special claims of this paint are that it will not crack, peel or wash off, that it is elastic and is adapted to tropical or cold climates. As a paint for preventing rust it is particularly well adapted. This composition is used extensively by the Manhattan Elevated R. R. Co., as well as by a large number of well-known steamship lines, and by the Boston and New Bedford Light House Boards. The offices have recently been removed from 14 South street, to 77 South street, New York.

FIRE ALARM SERVICE.—Among the recent installations of the Montauk automatic thermostatic fire protective cable was the placing of an equipment in the home of Joseph Pulitzer, proprietor of the New York *World*, by the firm of Stanley & Patterson, of New York. The summer and winter residences of George Taylor, New York, and A. A. Cowles, president of the Ansonia Brass & Copper Co., have also recently been equipped with a complete installation of this cable. The claims for this cable are that it requires no exterior aids; the fact that it accomplishes certain results, and that it is based on a natural law, renders it independent of exterior support such as is usually sought for by devices intended to accomplish, in a measure, like results. This cable is manufactured by the Montauk Multiphase Cable Co., 100 Broadway, New York.

EXPORTING AMERICAN POWER.—The Bullock Electric Mfg. Co., Cincinnati, O., is exporting weekly a large number of generators, motors and other specialties to England and other foreign countries. Cassell & Co., London, the largest publishing house in England, gets one of this company's 25 horse power, type O. printing press motors, with controller, and other firms in Great Britain which will receive Bullock motors, generators and printing press equipments are the Manchester "Sporting Chronicle," Belfast "Evening News," London "Daily News," the Machinery Trust, Ltd., of Chester; Thornycroft shipbuilding yards, Richard Moreland & Co., London, and Charles Churchill & Co., of Birmingham. The shipments made to the newspaper establishments will be the most important that have ever been made from this country to the other side. This company will soon increase its facilities again.

HEAVY BRONZE CASTINGS.—We learn from J. J. Ryan & Co., 68-74 West Monroe street, Chicago, Ill., that they recently have been in receipt of so many orders for heavy bronze castings that they were obliged to tear out most of their old furnaces and replace them by others large enough to give them the required tonnage. Orders received by this firm from F. W. Wolf Co., Chicago, and the American Steel & Wire Works, in May, called for a number of heavy phosphor bronze bearings weighing upwards of 400 lbs. each, and others 550 lbs. each. This company reports business in aluminum castings as assuming important dimensions. They have just finished a large order for the Otis Elevator Co. in this metal, the patterns of which were all in plaster of paris, originally modeled in wax and of varied and elegant designs. The firm has a single order for July delivery for a car load of brass castings aggregating 26,000 lbs. Their trade in Babbitt metal is also increasing steadily.

Disinfecting Spray Pumps.—A full line of pumps made for all purposes of spraying and especially for disinfecting is manufactured by the Deming Co., Salem, O., and an interesting catalogue is published describing the various types of these pumps.

Primus Oil Stoves.—For yachts and other small vessels in which the space for cooking is limited the Primus stove, manufactured by the Primus Co., 197 Fulton street, New York, has proved very popular. These stoves are made in various sizes and by transforming the kerosene into gas give an intense heat. Circulars can be had by applying to the manufacturers.

Launch for Dutch Guiana.—The Marine Vapor Engine Co., foot of Jersey avenue, Jersey City, N. J., has just delivered to the Marowyne Mining Co., for use at its mines in Dutch Guiana, S. A., a 30 ft. launch, equipped with a seven horse power Alco vapor motor and all necessary appurtenances. This launch was shipped on the deck of a schooner, with complete mining apparatus.

Electric Heaters.—A full line of electric heaters is manufactured by the United Electric Heating Co., 252 Randolph street, Detroit, Mich. Many of these heaters are particularly adapted to marine work, such as radiators for heating cabins, chafing dishes, coffee pots and other cooking utensils, hot water heaters, etc. An interesting circular regarding these specialties is sent to all inquirers.

Injector Litigation.—The litigation which has been going on for some years regarding injector patents has been settled so far as the Penberthy Injector Co., Detroit, Mich., is concerned by this company purchasing the Loftus "ring and valve" injector patent. By special arrangement this patent is used by the American Injector Co., of Detroit, and by the Hancock Inspirator Co., of Boston, which reserved the right to manufacture when it disposed of the patent.

Utica Steam Gauge Co.—The announcement is made that Mr. Ralph G. Harmon, who has been well-known in the trade for many years, has been elected secretary of the Utica Steam Gauge Co., Utica, N. Y. Mr. Harmon's acquaintance and abilities will be a great addition to the Utica company, especially as this company has only recently opened a large and completely equipped plant, giving every facility for manufacturing its special goods. This company has had an experience of forty years in the manufacture and sale of steam gauges.

Tin Roofing.—Merchant & Co., Inc., 517 Arch street, Philadelphia, Pa., recently prepared and are now sending out three treatises on tin roofing. The first explains thoroughly "How Roofing Tin Is Made;" the second tells "How a Tin Roof Should Be Laid and Painted," and the third shows in detail the difference between their method of manufacturing plates and the old Welsh method, and reasons for claiming superiority for their method. Engineers and others of our readers interested in this material should send for copies of these pamphlets.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

ENGINEER AND DRAUGHTSMAN SEEKS POSITION.

A mechanical engineer and draughtsman is open for a position. Is experienced in the designing of marine and Ohio river engines. Address L. M. HARTWICK, Marietta, Ohio.

TO LAUNCH AND GASOLINE ENGINE BUILDERS.

An expert in design, construction and equipment of power launches desires an engagement as superintendent, manager or head of department. An engagement preferred with a firm building or intending to build first-class moderate priced launches and equipments. With this class of work advertiser has averaged 20 per cent net profit based on lowest selling prices. For highest references and full particulars address

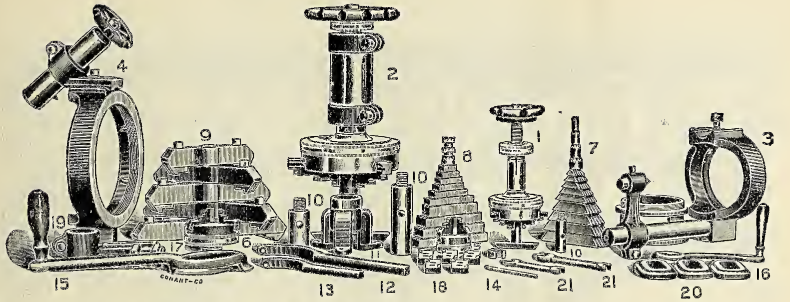
GASOLINE, care Marine Engineering,
World Building, New York.

Marine Repair Work.—The Morse Iron Works, foot of Twenty-sixth street, Brooklyn, N. Y., are very busy. They have just finished overhauling three of the Prince Line steamers. They are now refitting the transport *Missouri* for the hospital service in the Philippines; also overhauling and repairing the transports *Buford*, *Kilpatrick*, *Dixie* and *McPherson*. The English tramp *Ivydene* is being likewise overhauled. Repairs are being also made to the yachts *Nourmahal*, *Rahda*, *Nooya* and *Wanda*. The latter was used by the Associated Press in Cuban waters during the war.

Steel Wool and Sand Paper.—A recent invention which is proving very popular where the polishing of wood and other surfaces is required is the steel wool manufactured by the Buehne Steel Wool Co., 15 Dey street, New York. It can be used in every place where sand paper is used, and is taken up by the handful. It is soft and pliable and can be used many times without much deterioration. Foreign substances are readily shaken from a bundle of it. For scraping purposes it has proved itself especially useful, as its cutting power is great. Fuller information regarding this can be had from the manufacturers.

The London Times Says:—"At the present moment when so much attention is being directed to the question of the most suitable water tube boiler for the British Navy, it may be of interest to note that the Yarrow boiler (which is a boiler fitted with small straight tubes) has been fitted with the most successful results to the following cruisers, viz.: The three Dutch cruisers *Holland*, *Zeeland* and *Friesland*, the Portuguese cruiser *Don Carlos* and the Austro-Hungarian cruiser *Zenta*, thus showing that this type of boiler which has proved itself so efficient in torpedo-boats and torpedo-boat destroyers, is equally applicable to larger vessels."

The "Taylor" Yacht Boiler.—The president of the Iron Trade Review Co. was aboard the *Enquirer* during her race with the *Say When* and watched closely the working of the boiler, which was one manufactured by the Detroit Screw Works, Detroit, Mich., and later, in writing to the firm, said the *Enquirer's* boiler was popping off all the way up, and in fact when crossing the finishing line was popping off steam. Both the engineer and fireman declared they had no difficulty whatever in keeping up all the steam they wanted, and that they were much pleased with the way the boiler acted. The difference between the boats at the finish was only twenty-eight seconds.



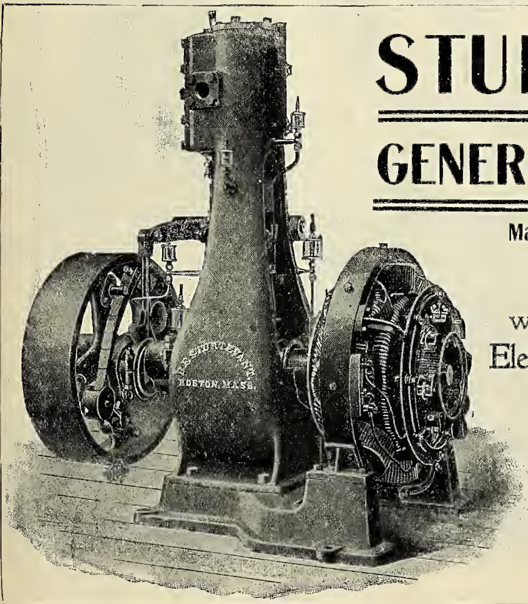
ALL THE MIGHTY BATTLESHIPS

In the U. S. Navy keep their valves absolutely steam tight with the Morse and Dexter Valve Reseating Machine. Every progressive engineer who takes pride in adopting up-to-date methods insists upon having the "Morse and Dexter" Machines.

We are always willing to send a machine on 30-days' trial, or a longer period if necessary, for the user to test the working of the machine. Our catalogue shows all the different sizes and prices of the same.

THE LEAVITT MACHINE CO.,

ORANGE, MASS., U. S. A.



STURTEVANT

GENERATING SETS

Made in 8 styles and 50 sizes.

1½ to 100 K. W.

With Vertical and Horizontal Engines.

WE ALSO MAKE . . .

Electric and Steam Fans
for Boiler Draft or
Ventilating Work.

HEATING APPARATUS.

STEAM ENGINES, ETC.

B. F. STURTEVANT CO.

BOSTON	NEW YORK
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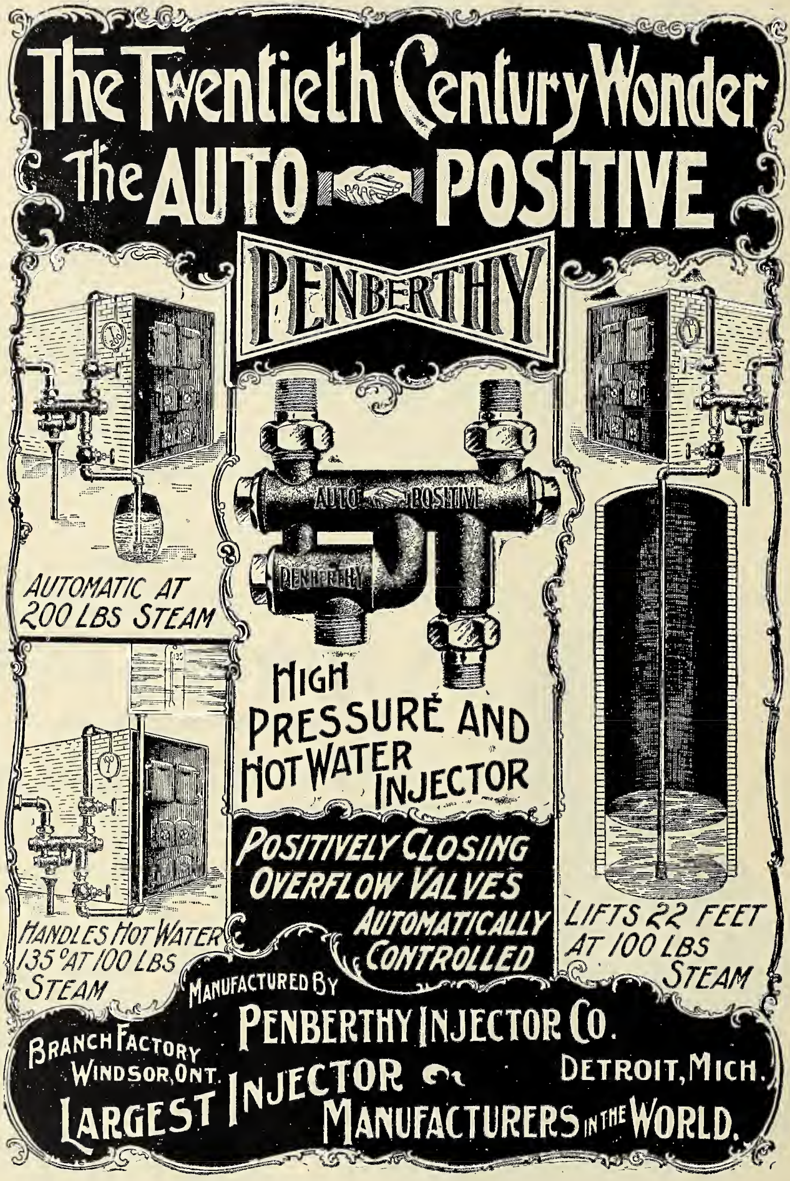
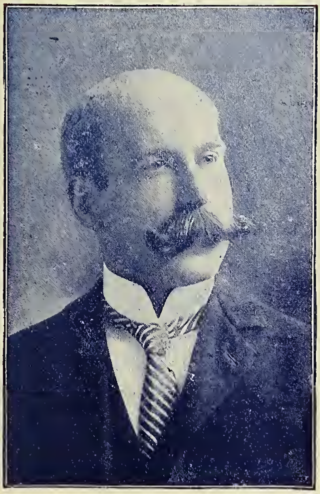

The Twentieth Century Wonder
The AUTO POSITIVE
PENBERTHY
AUTO POSITIVE
PENBERTHY
AUTOMATIC AT 200 LBS STEAM
HIGH PRESSURE AND HOT WATER INJECTOR
HANDLES HOT WATER 135° AT 100 LBS STEAM
POSITIVELY CLOSING OVERFLOW VALVES AUTOMATICALLY CONTROLLED
LIFTS 22 FEET AT 100 LBS STEAM
MANUFACTURED BY
PENBERTHY INJECTOR CO.
BRANCH FACTORY WINDSOR, ONT.
DETROIT, MICH.
LARGEST INJECTOR MANUFACTURERS IN THE WORLD.

Rainbow Packing

"THE KING OF RAINBOW."



MR. CHARLES A. HUNTER.

General Supt. of the Peerless Rubber Mfg. Co., succeding his brotherinlaw, the late John H. Deming, the sole inventor of Rainbow Packing. Mr. Hunter is the only living man who has ever made or knows how to make Rainbow Packing in its entirety, having been educated and trained in the business for the past twelve years by his late brotherinlaw, John H. Deming, for the purpose of fitting him for his present position.

THERE IS NO OTHER "JUST AS GOOD."

NONE GENUINE WITHOUT THE TRADE MARKS.

The word **RAINBOW** in three rows of Diamonds in Black, extending through the entire length of each roll.

THE COLOR OF RAINBOW IS RED.

Fac-simile of a Roll of Rainbow Packing.

IMITATIONS.

Manufacturers of all classes of rubber goods have attempted to imitate **Rainbow Packing.** They have **Misrepresented** and are still **Misrepresenting** as to the merits of their **Worthless** imitations. They have stated that they have hired our superintendents and other employees, thereby obtaining the secret of making **Rainbow Packing, which is Absolutely False.** The secret of this **Packing** is known to two men only, **Mr Charles A. Hunter,** our Superintendent, and **Mr. C. H. Dale,** the President of this company. **Mr. Hunter** is the only living man who has ever made it in its **Entirety. Rainbow Packing** passes through at least one hundred different processes before reaching the market.

HISTORY OF RAINBOW PACKING.

RAINBOW packing was first introduced in the year 1889, by **Mr. Charles H. Dale.** The entire process of the manufacture of this packing is a secret which is known only to **Mr. Chas. A. Hunter,** our Superintendent, and **Mr. Charles H. Dale,** President of this company. Its origin was an accident. A prominent merchant made a suggestion to **Mr. Dale,** then General Sales Agent of this company, as to constructing certain material. In attempting to carry out his suggestion we met with failure, and found a large batch of compounded rubber on our hands. Our late Superintendent, **Mr. John H. Deming** thought he could utilize this rubber and added different material to it, and colored it red, with a view of making sheet packing of it, and to our surprise was produced what all the world knows at the present time as the **Only Effective Flange Packing in the World.** Its color signifies nothing. It was simply a dirty brown color, and the coloring matter was originally put in to make it more presentable, and from the color its name **Rainbow** originated. The fact exists that it stands alone to-day as the only packing in the world that can be put in a joint and a full pressure of steam applied **Immediately without any baking or following up,** with every **Joint Guaranteed Perfectly Tight and True. Rainbow** is the **Acme** of success. In other words it is everything that could be desired in a sheet packing, perfect in every detail, with no faults.

PATENTED AND MANUFACTURED EXCLUSIVELY BY

The Peerless Rubber Manufacturing Company,

16 WARREN STREET, NEW YORK.

THESE GOODS CAN BE OBTAINED AT ALL FIRST-CLASS HOUSES.

THE PEERLESS

SPIRAL PISTON AND VALVE ROD PACKING.

READ OUR LATEST TESTIMONIALS.

204 TWENTIETH STREET,
DETROIT, MICH.

March 15th, 1899.

PEERLESS RUBBER MFG. Co.,
16 Warren St., New York.

Gentlemen:

Your circular to hand and noted. I would say I have used your Peerless packing, Rainbow packing and Eclipse Gaskets for several years, and they have given me the most perfect satisfaction. I would not think of changing these packings for any other brands, and I hope you will always retain the high quality of these packings and gaskets. I can truthfully say I have had the least trouble with your goods of any I have ever used in an experience of a good many years. The Peerless gives me no trouble at all. The Rainbow I do not have to follow up, and of the Eclipse Gaskets I would say I used one on my boiler for fourteen months, and the boiler was opened every two weeks. So I can truthfully claim these goods are the best I have ever seen or used.

Wishing you continued success, I remain,

Yours respectfully,
John D. Whitehead,
Chief Engineer.

PEERLESS SPIRAL PISTON & VALVE ROD PACKING

LOOK FOR THIS LABEL ON EVERY BOX.

TWELVE TO EIGHTEEN MONTHS IN HIGH SPEED ENGINES WITHOUT REPACKING.

Eclipse Sectional Rainbow Gasket.

3/8-INCH FOR PIPE UNIONS.

1/2-INCH FOR HAND HOLES.

5/8-INCH FOR REGULAR SIZE.

3/4-INCH FOR LARGE SIZE MAN HOLES.

Fac-simile of a 6-inch section of Eclipse Gasket, showing name and trade-mark imbedded.

SEND FOR CATALOGUE.

PATENTED, COPYRIGHTED AND MANUFACTURED EXCLUSIVELY BY

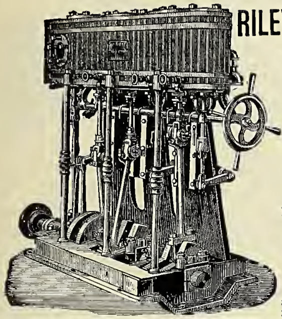
The Peerless Rubber Manufacturing Company,

16 WARREN STREET, NEW YORK.

16-24 Woodward Avenue, DETROIT, MICH.

17-19 Beale St and 18-24 Main St., SAN FRANCISCO, CALIFORNIA.

202-210 South Water St. CHICAGO, ILL.



RILEY & COWLEY,

Machinists

—and—

Engineers,

Richards St., Cor. Bowne, South Brooklyn, N. Y.

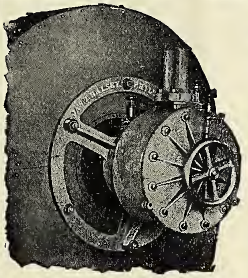
Builders of Compound and Triple Expansion Engines for Steam Launches, Yachts and Tow Boats.

Repairs in all of the above branches upon reasonable terms.

STEAM MOTORS

FOR

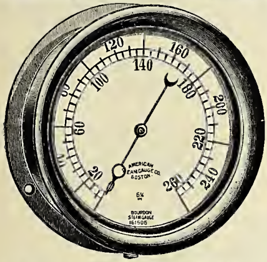
Forced Draft Fans and Driving Boats.



Require no attention.
Used on the American Line 3 years.
Not a rotary engine,
500 to 2,000 revolutions per minute.
Single expansion or compound.
Economy guaranteed.

JAMES T. HALSEY,

26th and CALLOWHILL STS. PHILADELPHIA, PA.



AMERICAN PRESSURE AND VACUUM GAUGES

BOURDON & LANE'S PATENTS.

Ammonia, Hydraulic, Locomotive, and Altitude Gauges. Water Gauges, Gauge Cocks, Clocks, Counters, Whistles, Pyrometers, Chime Whistles, Salinmeter Pots, Thermometers, Test Pumps and Test Gauges, and All Kinds of Steamship Instruments.

AMERICAN STEAM GAUGE CO., 34-36-38 Chardon Street, Boston, Mass.

PROFESSIONAL CARDS.

GARDNER & COX,

Naval Architects, Engineers and Yacht Brokers.

1 Broadway, New York.

WILLIAM GARDNER.

IRVING COX. TELEPHONE CALL, 2007 BROAD.

GUSTAV HILLMAN,

Naval Architect.

Designer of all classes of **Vessels. Steam Yachts a Specialty.**

470 Greene Ave., near Nostrand, Brooklyn, N. Y.

H. B. ROELKER,

Consulting and Constructing Engineer.

Manufacturer of **Screw Propellers** for Usual and for Special Work.

The Allen Dense Air Ice Machine for Steam Vessels.

41 Maiden Lane, New York.

Binders. We have some neat and strong Binders made especially for preserving copies of MARINE ENGINEERING. Get one and protect your magazines. Price 75 Cents, postage paid.

ALDRICH & DONALDSON,
World Building, New York.

On all your Marine work

Endorsed and liberally used by intelligent steam users everywhere.

THE....

Lunkenheimer Company,

General Offices and Factories... **Cincinnati, U. S. A.**

Branches:
26 Cortlandt Street, NEW YORK.
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Sole Makers and Patentees of the Celebrated

"Lunkenheimer" Specialties,

...COMPRISING...

Regrinding Globe,	Steam Whistles,
Angle, Check Valves,	Chime Whistles,
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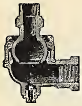
Clip Gate Valves,	Sight-Feed Lubricators
Victor Gate Valves,	Glass-Body Oil Pumps,
Double Disc Gate Valves,	Boiler Oil-Injectors,
Handy Gate Valves,	Grease Cups,
Lever Throttle Valves,	Oil Cups,
Pop Safety Valves,	Loose-Pulley Oilers,
Steam Cocks,	Oiling Devices,
Water Gauges,	Etc., etc.

"LUNKENHEIMER" on any article is a guarantee for superior quality, efficiency and durability. Endorsed by intelligent steam-users everywhere. Provide against substitution by specifying "Lunkenheimer" make. Write for catalogue.

specify "Lunkenheimer" fittings and

get the best. It pays.



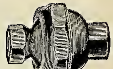
Angle Joint, Showing Automatic Steam Trap

MORAN FLEXIBLE JOINT

For STEAM, AIR OR LIQUIDS

Made in all sizes to stand any desired pressure.

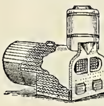
Send for reduced price list, in effect April 1, 1898.



Straight Joint

MORAN FLEXIBLE STEAM JOINT CO., Inc'd. 153 THIRD STREET LOUISVILLE, KY.

Telephone Call: 1515 Cortlandt.



Estimates Furnished and Contracts Executed.

ROBERT A. KEASBEY,

Buffalo Office 13 TERRACE. TELEPHONE CALL SENECA 1384

K&M MAGNESIA & MAGNABESTOS SECTIONAL COVERINGS,

HEADQUARTERS FOR HAIR FELT, MINERAL WOOL. ASBESTOS PAPERS BRINE PIPE COVERINGS, ETC.

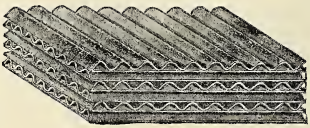
83 WARREN ST. New York City.

ASBESTOS AIR CELL FIRE BOARD!

(REG. TRADE MARK.)

For Lining of

Bulkheads.



For Covering

Steam Boilers.

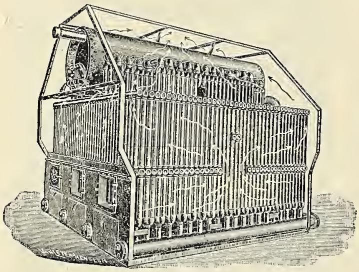
PATENTED.

New York Asbestos Mfg. Co.,

287-291 DOUGLASS STREET, - BROOKLYN, N. Y.

THE "TAYLOR" YACHT BOILER

Has held the record three seasons on the fastest yacht on the great lakes.



Guaranteed against Rupture of Tubes.

Will not Prime in the Roughest Sea.

MANUFACTURED BY

DETROIT SCREW WORKS,

FOOT OF REOPELLE ST.,

DETROIT, MICH., U. S. A.

"Gladiator"

ASBESTOS AND ASBESTO-METALLIC

High Pressure Gaskets and Boiler and Asbestos Materials

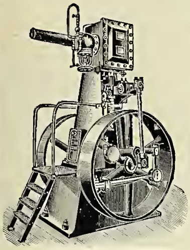
Steam Packings Jointings Pipe Coverings of all kinds

THE NEW JERSEY ASBESTOS CO.

Factory CAMDEN, N. J.

47 Dey St. NEW YORK.

SHEPHERD ENGINES



FOR...

Marine Lighting.

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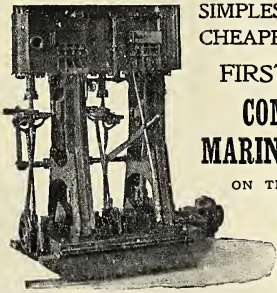

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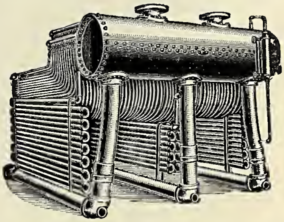

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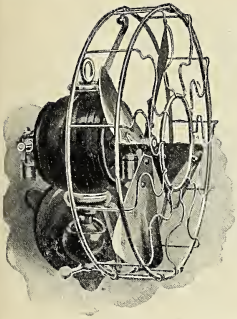

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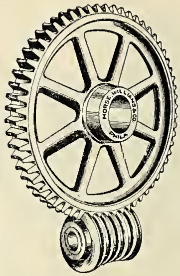

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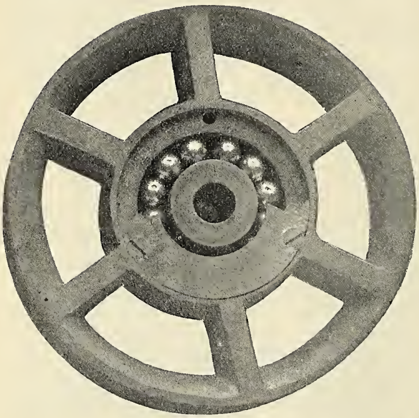

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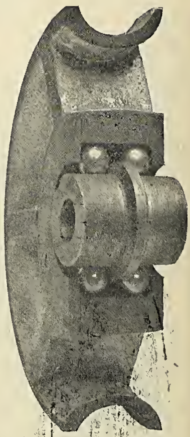

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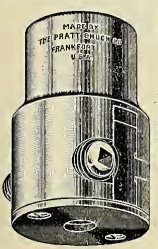

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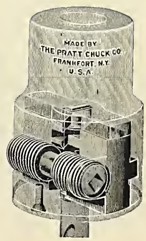

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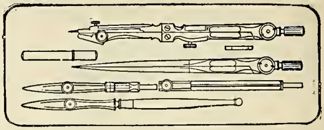

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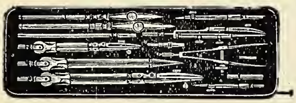

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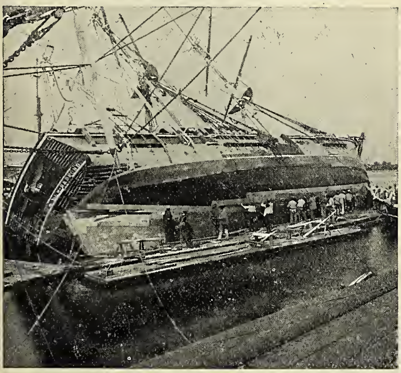

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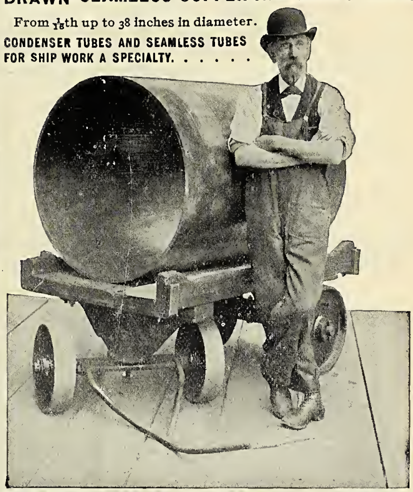

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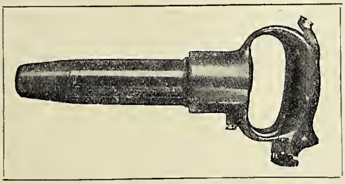

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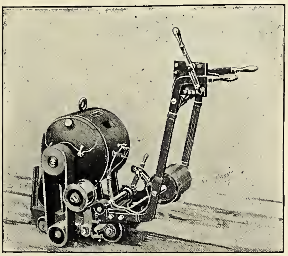

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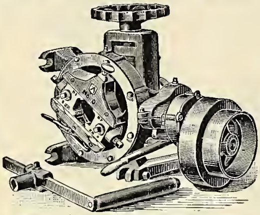

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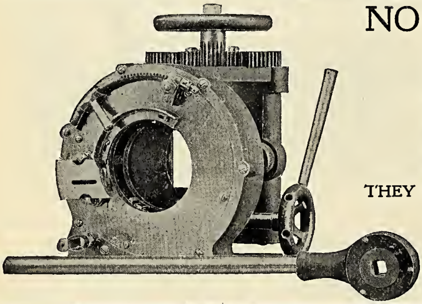

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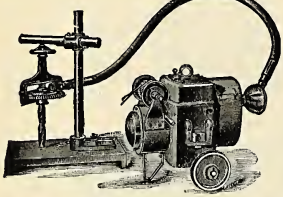

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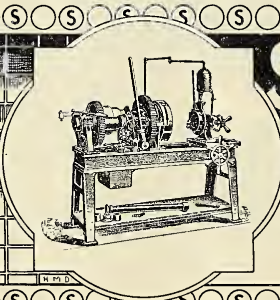

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INDEX TO ADVERTISERS.

(*Index continued on page 46.*)

INDEX TO ADVERTISERS—*Continued.*

INDEX TO ADVERTISERS—*Continued.*

(*Index continued on page 48*)

INDEX TO ADVERTISERS—*Concluded.*

TRADE PUBLICATIONS.

The Bullock Electric Mfg. Co., Cincinnati, Ohio, issued a very patriotic calendar for the month of July. It was beautifully lithographed in several colors.

A large folder is issued by the Cleveland Machine Screw Co., Cleveland, Ohio, illustrating its several sizes of automatic machines and the various products of these machines. These include almost everything that can be turned by machinery.

The Yale gas engine is nicely described and well illustrated in a catalogue 6 by 9 in. in size. This engine is made two cycle, unless otherwise preferred, and it is claimed to be one of the simplest engines offered to the public. The descriptive matter gives much detail of the construction and special advantages. This engine is built by the Denison Electrical Engineering Co., New Haven, Conn.

"Water Softening, a Balance for Users of Hard Water," is the title to a neatly printed pamphlet issued by the Wilson Co., 11 Broadway, New York. The printing is exceptionally attractive, with good paper and red and black ink. The cover is green, printed in black and gold. Much information is given regarding the matter of water for steam-making, and the illustrations show the manner in which the softener is utilized.

Several types of portable forges manufactured by the Empire Forge Co., Lansingburg, N. Y., are fully described in catalogue No. 28, just issued. Many illustrations are given showing the several types and kinds of forges, and each is briefly described and other information given, including the size, height, weight, etc. Other specialties of this company are also illustrated, including sash balances, which are specially adapted to marine work; also blowers, etc.

Modern improved marine railways have a catalogue of much value devoted to them by the well-known builders, H. I. Crandall & Son, East Boston, Mass. The catalogue is 8 by 11 in. in size, and contains many full-page engravings showing to much advantage the Crandall improved marine railway. The type of engine used with these railways is fully shown in a large engraving, and in other detail all the information one would desire is given.

Kriebel single and double cylinder engine, 1 to 60 horse power, is illustrated and described in a catalogue issued by the manufacturers, Bugbee & Laycock, 128-130 South Clinton street, Chicago, Ill. The several types of engines are illustrated fully and the vertical submerged tube boiler recommended for use with this engine is also illustrated and described. Considerable information is given regarding the engine for propelling boats; also for hoisting apparatus and for other uses.

Users of manila rope will find much of interest in a catalogue issued by the C. W. Hunt Co., Joel Ave., West New Brighton, New York city. This catalogue contains tables, knots and other valuable information regarding the use of rope, and illustrates and describes in an interesting way the manner in which "Stevedore" rope is made. Perhaps the most interesting part of this catalogue is the large illustrations showing the manner of splicing ropes and of making knots, hitches, bends, etc.

A handsome catalogue devoted to trucks is issued by the Kilbourne & Jacobs Mfg. Co., Columbus, Ohio. It is pocket size, 128 pages, and is devoted to a description of every conceivable kind of truck for wharves, steam vessels and all other uses. Each different type of truck, and the types are almost without number, is illustrated and concisely described, giving dimensions and other necessary information. There is an average of at least a cut to a page. These trucks are sold also by the Fairbanks Co., 311 Broadway, New York, from either of whom copies of the catalogue can be had.

Metallic Packing, manufactured by the United States Metallic Packing Co., 13th and Noble Sts., Philadelphia, Pa., has one of the handsomest catalogues of the season devoted to it. The several styles and kinds of packing are illustrated by half-tone engravings of the finest quality. The descriptive matter is ample and occupies about half of the catalogue, the other half being devoted to the engravings. Reference is made to many steamers upon which this packing is used in both the Navy and the merchant marine. Every engineer will want to send for a copy of this catalogue to preserve for reference.

"Navigation Made Easy" is the heading on a pamphlet issued by Captain S. R. Kirby, 223 Fifth Ave., New York, describing Kirby's great circular navigator. This instrument is designed for use in securing an accurate shaping of courses at sea under all circumstances. The special claim is that by this instrument a course can be laid without consulting any great circle diagram, and without making any astronomical calculation. A complete description is given in the catalogue, and large illustrations accompany the description, making plain the manner of operation. Captain Kirby will give further information should it be desired.

The fire alarm system of the Marine-Universal Fire Alarm Co., 925 Chestnut St., Philadelphia, Pa., is described and thoroughly illustrated in a very neatly printed catalogue. This system is not new, having been installed on all of the recently built vessels of the Old Dominion Line, as well as on other steamers. The illustrations in the catalogue show the manner of applying the system, and give a good deal of information regarding it. Several letters are also published speaking of the system in the highest terms as a necessity for reporting promptly all fires. Every man connected with marine work will find a copy of this catalogue of much value, because of the importance of the subject.

A very complete catalogue of 112 pages is received from the Truscott Boat Mfg. Co., St. Joseph, Mich. This company recently moved into a very large factory, and now has facilities for building pleasure boats of all sizes and kinds in the shortest period possible. This company builds its own vapor engines, and instals steam when desired. The catalogue is very profusely illustrated with types of boats of all kinds which this firm builds. All of our readers interested in pleasure craft should have a copy of this book. It can be had either at the home office or from the eastern agent, J. W. Newbury, 471 West 22d St., New York.

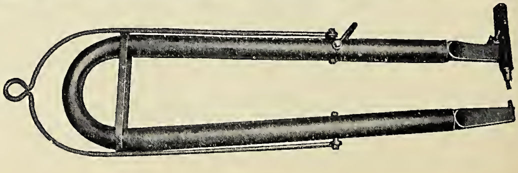
Electric and steam heating is considered in great thoroughness in a cloth bound and very handsomely published catalogue issued by the Gold Car Heating Co., Frankfort and Cliff streets, New York. Although the major part of the company's business has been with railroads, the heating systems are equally as well adapted to vessels of all kinds and have been made use of by a number of steamship lines and on some well known vessels. There are many large illustrations in the book, giving in much detail the entire workings of the several steam systems. Many smaller illustrations showing the detail of these systems are also given. The electric system of heating is already in use on many large steam vessels and is particularly adapted for yachts because of its compactness. The many types of electric heaters are illustrated and much information given regarding the use of electricity for heating purposes. The most important feature of the work is the manner in which each subject is illustrated. Altogether it is one of the finest catalogues, not only in its typographical effect, but in its general makeup, that this season has brought forth. Those of our readers who are interested in the subject of heating either by steam or electricity will find this book of great value.

Moroccoline, a covering designed especially for upholstering purposes, is described in a concise catalogue printed in two colors and issued by the Boston Artificial Leather Co., Boston, Mass. According to the catalogue this material has many advantages over leather, not only in its durability, but in not showing scratches and not becoming soft and sticky, as is often the case with other materials at sea. The price is said to be about one-third that of leather. Copies of the catalogue can be had from the company.

Portable forges, blowers, both crank and lever; screw plates, taps, dies and other specialties manufactured by the Champion Blower and Forge Co., Lancaster, Pa., have a very complete catalogue devoted to them. It comprises 165 pages, and is very profusely illustrated, some of the illustrations being in two colors. Nearly every device described in this catalogue is of the type that would be especially adapted for use on board of vessels or in shipyards, thus making the catalogue one of much value to our readers for reference. Copies can be had by applying to the company and mentioning Marine Engineering.

BUSINESS NOTES.

A Model Factory.—The machine shops of the Bullock Electric Mfg. Co., Cincinnati, O., illustrate the great economic progress made in manufacturing methods. There are no long lines of shafting and counter-shafting; no unsightly and light-forbidding belts. Each machine is driven by an independent Bullock electric motor, which absorbs power from the transmission lines only when it is required, and, by reason of all this, one is deeply impressed with the improved atmosphere and absence of the noise due to constantly running belts and shafts. Among the machines equipped are cranes, power presses, lathes, planers, drills, milling machines, profilers, emery grinders, hydraulic presses, boring mills, etc. The motors used for driving these various tools are designed and adapted for the tools mentioned, and are built into the headstock of lathes, while in other tools they take the place of the driving pulley and require no more room. The motors are of the Bullock slow-speed type with the variable speed control governed by the Bullock multiple voltage system. The tools may be operated in six varying speeds in either direction, without the use of back gearing or any resistance whatsoever in the electrical circuits. The economies effected by application of motors to machine tools, although in first cost slightly more expensive than the use of line shafts, belting and countershafts, soon justifies the additional expenditure. The output of the tool is largely increased on account of the multiplicity of speed obtainable, and the facilities for changing these speeds while the tool is in operation. Space is economized, as the tool may be located without reference to line shafting.



Change of Manager.—Mr. J. L. Weeks, who for twelve years has been manager of the western branch of the American Steam Gauge Co., 36 Chardon street, Boston, Mass., has been called to the head office and been made treasurer and general manager. This company has recently made extensive additions to its factory and otherwise improved its facilities for business, giving it every possible advantage in its special field for filling orders promptly and satisfactorily.

Bethlehem Company's Change.—On June 26 the Bethlehem Steel Co. formally took over the property, etc., of the Bethlehem Iron Co., which latter company has leased its works, etc., to the former company. The officers of the Bethlehem Steel Co. are: Robert P. Linderman, president; Edward M. McIlvain, vice-president; Abraham S. Schropp, secretary; C. O. Brunner, treasurer; R. W. Davenport, general superintendent; Owen F. Leibert, chief engineer, and Charles P. Coleman, purchasing agent.

Almy Boilers.—The Almy Water Tube Boiler Co., Providence, R. I., has had a specially active season, among the recent orders being six boilers of about 3,500 horse power capacity for the yachts which were designed by Gardner & Cox, 1 Broadway, New York, and are under construction at the Roach shipyard in Chester, Pa. Boilers are also being built for the Cape Ann Granite Co., to install on steam lighters, and a small Almy boiler will go into a launch which W. D. Forbes & Co., Hoboken, N. J., are building.

A New Pilot House Indicator.—D. H. Vernuille, Mobile, Ala., has recently invented an indicator for use in the pilot house. This indicator is connected by wire to the cam rod, and when the engine is reversed, this change of motion is shown on the instrument. On the latter are the words "back" and "ahead," and at each change of the engine there is a tap on a gong, one gong being large and the other small, so that the sounds will be different. This indicator is now in use on the steamer *Mobile*. The device is commented upon very favorably by local experts and special reference is made to the fact that it is entirely mechanical.

Shepherd Engines.—Although the Shepherd engine has been on the market for but a brief period of months it has made ready sale, not only from the home office, the American Fire Engine Co., Seneca Falls, N. Y., but through the several agencies. The New York representatives, Burhorn & Gander, have sold six cross compounds for use in the U. S. Navy, two of them being direct connected to C. & C. generators, and four to Thresher generators. Several of these engines have also been sold for direct connected sets, the generator being furnished by the Onondaga Dynamo Co., Syracuse, N. Y. A set sold to the Plant system was direct connected to an Eddy dynamo.

Old Reliable Submarine Composition.—In writing to the manufacturers of the Old Reliable Submarine Composition, which is manufactured by M. J. Williams, 77 South street, New York, the superintendent of the Sag Harbor Steamboat Co. stated: "I think it my duty to give you this recommendation for your 'Old Reliable' submarine compositions, which you applied on the bottom of our steamboat *Montauk*, March 29, on Brown's Dock, Jersey City. She looks as good to-day as when she came off dock. We painted the *Shelter Island* with another composition three weeks after, and before she was in the water one month we were obliged to put your composition on her line as far as we could reach to save the iron from rust and fouling. Where your composition is applied there is no fouling or rust, but before it was very foul and rusty."

Marine Electric Plant.—In writing to Thomas P. Benton & Son, La Crosse, Wis., the firm of Weyerhaeuser & Denkmann, Rock Island, Ill., say: "We have on our steamboats four of your make dynamos; three of them series wound, and used exclusively for searchlight. The fourth, compound wound, serves the double purpose of searchlight and that of lighting the boat with incandescent lamps. The machine is intended for but 40-16 C. P. incandescent lights, in addition to the 10,000 C. P. searchlight, but we have 71 lights added, and with the entire load the machine runs very smoothly and quietly, never heating nor sparking. It adjusts itself to its load so closely that on throwing on or off the searchlight there is a perceptible difference of from but two to four volts. It is needless to say that your machines have given us excellent satisfaction, and that at any time, when in need of new ones, we would be pleased to give you the preference."

Watertight Doors.—Many of our readers will be interested in a test of the long arm system of watertight compartments installed on the cruiser *Chicago* under the auspices of the Long Arm System Co., Garfield Building, Cleveland, Ohio. The aim of the system, as explained by the promoters, is: First: to construct all the doors and hatches in the cellular structure in such a manner that they will close and open freely and with certainty; automatically locking watertight on their seats by the act of closing and unlocking and freeing themselves automatically by the act of opening. Second: to place all of said doors and hatches under power control from a central station, so that they may be closed quickly and simultaneously at any moment, in case of need, and so that any door or hatch may be operated independently at any time. The kind of power used may be either liquid or pneumatic pressure. When some sort of hand gear is required, to use in case of accident to the power, a small hand pump can be made the ideal thing; this points to the use of liquid pressure. As a result of these tests the Navy Department will, we are informed, introduce this system on the three new battleships.

ZINC WHITE IN MARINE PAINTING.

Within a few years after the discovery of the modern process for making zinc white, the French naval authorities, after severe tests, ordered its use to the exclusion of white lead on the interior of all vessels of the French navy. Experience has confirmed its superiority for painting structures exposed to sea-air and sea-water, and the French navy as well as the French steamship companies now universally employ it, while it is also the official base for painting lighthouses and Government work on the seashore. The French marine authorities also use it for painting galvanized iron plates, the hulls of torpedo boats, the shells of metal pontoons, etc.

That the French navy should have been earliest to adopt this practice is natural, since zinc white was first generally introduced in France. But the naval authorities of the United States, having made their own experiments with the same results, have adopted zinc white as the fixed component of all paints used either in the Navy or by the Lighthouse Establishment. The famous "White Squadron" obtained its color from zinc white, and remained white because zinc does not change color. Ten tons of American zinc white is the cruising allotment for each ship, and it is used liberally and effectively.

Similar testimony is found in the U. S. Lighthouse specifications, which require, for white, a mixture of one-fourth lead and three-fourths zinc, and for tinted paints, American zinc white and yellow ochre, with no lead. "The colored paints are wanted for outside use and are required to withstand the bleaching effects of salt water and sunlight."

The durability of zinc white is due to its chemical stability and to the large proportion of oil it carries to the painted surface. No other white pigment approaches it in this respect. It is the one white paint material that is capable of resisting salt water and salt air. Added to other materials it shields them and gives them durability.

Advt. NEW JERSEY ZINC CO.

Merchant & Co.'s Babbitt Metal.—The Chicago & Aurora Smelting & Refining Co., with works at Chicago and Aurora, Ill., and Leadville, Colo., has been merged into the American Smelting & Refining Co., which owns the principal large smelters of the country, having abandoned the manufacture of babbitt metal, excepting the filling of a few orders on hand, although having made a specialty of the manufacture of this material for engines, rolling mill works, etc., in the past two years. C. H. Reeves, Jr., who was in charge of this department, has therefore resigned his former position and become identified with Merchant & Co., Inc., of Philadelphia, New York and Chicago. Merchant & Co., Inc., have been operating large smelting works for a long period of years in Philadelphia and have always been very active in the manufacture of babbitt metals. They are now in position to supply the former customers of the Chicago & Aurora Smelting & Refining Co. identically with all the "Aurora" grades of babbitt metal they have been accustomed to use.

DRAUGHTSMENS' PENCILS.—Draughtsmen who are particular as to the quality of their pencils, and who need something suited to their own particular needs, will find a complete line of everything of the pencil order manufactured by the Dixon Crucible Co., Jersey City, N. J. This company makes a specialty of high grade pencils adapted to all the needs of draughtsmen.

FLUSH SWITCHES.—Electricians and others interested in electric work will be interested in the line of improved Stevens switches, manufactured by the Electric Protection Co., 1026 Filbert street, Philadelphia, Pa. The type of these switches is illustrated in a four-page folder, copies of which will be sent to all inquirers.

RIVER BOAT ENGINES.—Those of our readers interested in river boat engines will be interested in a circular issued by D. M. Swain, Stillwater, Minn., illustrating his poppet valve engine with adjustable cut-off. This engine is briefly described in the circular and a picture is given of the packet *La Salle*, which runs on the Illinois river.

ELECTRIC WELDING.—The electric welding department of the Standard Tool Co., Cleveland, Ohio, has been transferred to a newly organized company called the Standard Welding Co., with offices on Central avenue, corner of Cone street, Cleveland, Ohio. This company will carry on the seamless steel tube and general welding business.

RUBBERBESTOS PACKING.—The rubberbestos packing manufactured by A. W. Chesterton & Co., 49 India street, Boston, Mass., has been recently improved by using flat gum core packing instead of the previous round core. Finely spun linen is used over a core made of the celebrated rubberbestos compound, and each ply is well lubricated. This insures a durable, expansive and frictionless packing.

ACETYLENE SEARCHLIGHTS.—J. B. Colt & Co., 7 West Twenty-ninth street, New York, have recently received orders from the United States Government for "Criterion" acetylene gas generators and for acetylene search lights for the signal service. It is understood that this order is the result of the success of this apparatus during the recent Spanish war. It is reported that signaling was successfully done at a distance of forty-five miles at night.

ALMY BOILERS.—A recent copy of the Chester (Pa.) "Times" gives an interesting description of the Roach shipyard, in which is described a large number of Almy boilers, recently received for installing in the several fine steam yachts which this company is now building.

AUTOMATIC SMOKE PREVENTER.—The smoke preventer being put on the market by the Pennsylvania Automatic Smoke Preventer Co., 655 The Bourse, Philadelphia, Pa., has been tested, it is said, with much success. One of the severest tests was made in the U. S. Treasury building. Chief Engineer J. A. Watts, of the Treasury Department, reported that by the introduction of this system the smoke nuisance was eliminated and that a considerable saving was effected. This test was made with West Virginia soft coal. A similar test was also made at the Capitol building with anthracite coal, and Engineer W. Mooney, who conducted it, also reported favorably. A circular is issued by the company briefly describing the system and showing the manner in which it can be applied to marine boilers.

BABCOCK & WILCOX BOILERS.—The recent great increase in the demand for water-tube boilers has been the means of bringing large business to the Babcock & Wilcox Co., 29 Cortlandt St., New York. This company now has 26,000 horse power under construction. One of the largest orders ever given for water-tube boilers was received by this company, being for the four 500 ft. steamers recently ordered of the American Shipbuilding Co. for service on the Great Lakes. Another order was for a steel steamer which Wolff & Zwicker, Portland, Ore., have contracted to build for the Alaska Packers' Association. In this connection a recent test of the Babock & Wilcox boilers, built for the Government vessel *Alert*, has been reported before the American Society of Naval Engineers. This vessel has two boilers placed side by side with a passageway between facing an athwartship fire room. The dimensions are: Length at bottom of ash pit, 11 ft. 1 in.; distance from boiler front to perpendicular from center of drum, 19 in.; length at top from back end to center of drum, 10 ft. 5. in.; height from bottom of ash pit to center of pit, 10 ft. 8 in.; width, 8 ft. 9 in.; steam drums, 42 in. inside diameter and ½ in. thick. Each boiler had 364 2-in. tubes and 32 4-in. tubes, a total heating surface of 2,125 sq. ft., and a grate surface of 48 sq. ft., giving a ratio of 44 to 1. Four separate tests were made. The first and third for maximum rate of combustion, the second as to draft and steam pressure, and the fourth to show the efficiency of the boiler using hard coal and a moderately strong forced draft. In the first three tests Cumberland coal was used. Some very interesting results were obtained. The first test was with cold air, closed ash pit draft and steam jet in the smoke pipe. The average steam pressure was 234 lb., number of pounds of water vaporized 104,361 lb., fuel consumed 13,073 lb. of dry coal, and refuse 967 lb. The second test was with an open ash pit, a steam jet being used in the chimney. The third test was with heated air, closed ash pit draft and a steam jet in the chimney. The fourth test was with cold air, closed ash pit draft, and a steam jet in the chimney. The full data of these tests are published by the manufacturers. In closing the report of these tests the following statement is made: "Generally speaking, the tests conducted must be regarded as most satisfactory. The boiler did its work under natural and under forced draft with good economy and without distress. The comparatively low temperature of the uptake gases during all the tests, both with and without the air heater in use, seems to indicate that the air heater is not a necessity in combination with a boiler of the design under consideration, and cannot be considered a desirable adjunct except, possibly, when working at very high rates of combustion."

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

BOAT BUILDERS WANTED.

We are looking for competent boat builders. Write, stating experience, to PALMER BROS., Mianus, Conn.

TUG BOAT WANTED.

Subscriber is in the market for a tug boat not over 18 ft. draught, surface condenser, wood or steel hull (wood preferred). Send full particulars to TUG BOAT, care MARINE ENGINEERING, World Building, New York.

TRADE PUBLICATIONS.

A set of moving pictures is issued by the Boston Belting Co., 256 Devonshire St., Boston, Mass., which will be sent to all inquirers.

A sheet 10 by 13 in. in size is issued by Captain M. De Puy, 19 South St., New York, regarding his Paragon boiler. On the back of the sheet is a large sectional drawing showing the construction of the boiler, adding to the value of the sheet.

"Brazing by Immersion" is the title to a very complete 50-page pamphlet issued by the Joseph Dixon Crucible Co., Jersey City, N. J. The text is very fully illustrated, and to those of our readers interested in the subject of brazing, this book will be found of much interest.

A circular regarding the Dundon water-tube boiler is being distributed by the Dundon Iron Works, 223 Folsom St., San Francisco, Cal. Views of the boiler are shown both with and without casing. This boiler is one of the latest ones which have been approved for marine uses by the U. S. Inspectors.

The special courses of study offered by the International Correspondence Schools, Box IIII, Scranton, Pa., are described in much detail in a pamphlet devoted to this subject, and a similar pamphlet regarding the electrical engineering course is equally interesting, and will undoubtedly be of much interest to many of our readers, as the subject will appeal to almost every engineer.

The Dirigo rubber goods manufactured by the Dirigo Rubber Co. have a well illustrated and convenient pocket size catalogue ready for distribution. Packings of gaskets of all kinds are well illustrated, and a good deal of information is given which will interest steam users. Other steam specialties are also referred to. Copies of this catalogue can be had from John M. Watts Sons, 126 Liberty St., New York.

The electrical dynamos and motors manufactured by the Bullock Electric Mfg. Co., Cincinnati, Ohio, have a very complete, handsomely printed and beautifully illustrated catalogue devoted to them. The illustrations are large and very finely made, and much attention is devoted to lines of work of special interest to our readers. A bit of history regarding the remarkable growth of this company is given, and a concise description accompanies each one of the illustrations.

A very daintily and artistically printed pamphlet in colors is issued by the Advertising Department of the Westinghouse Co.'s, Pittsburg, Pa., on light and power installations for private residences and hotels. The catalogue refers especially to the Westinghouse gas engines which are extensively used for operating isolated electric lighting plants. Many buildings, both private and public, are illustrated in which these Westinghouse plants have been installed, and a number of plants in these buildings are also illustrated. As gasoline can be used for fuel in these engines a plant can be adopted for almost any purpose.

The Sturtevant engine has a special catalogue devoted to it. The catalogue is printed on heavy coated paper, and the many types of this well known engine are illustrated, both alone and direct connected with electric lighting apparatus. The catalogue comprises nearly 50 pages, and in addition to the many engines described, contains valuable data, tables of horse power, etc. It is a very valuable catalogue for reference. In this same connection it is interesting to note two bulletins, the second editions of which have just been issued by the Sturtevant Co. Bulletin H is devoted to the Sturtevant electric fans, and comprises several pages in which many types of fans are shown. Bulletin I is devoted to the Sturtevant 8-pole motors and generators.

A very complete pamphlet is issued by the Snow Steam Pump Works, Buffalo, N. Y., giving the reports of tests made by Professor W. F. M. Goss, of Purdue University, on a vertical triple-expansion crank and fly wheel pumping engine having a daily capacity of 20,000,0000 gallons. The engine referred to was designed and built for the Indianapolis Water Co., by the Snow Works.

The engine type of generators manufactured by the Bullock Electric Mfg. Co., Cincinnati, Ohio, is the subject matter of the August bulletin, No. 1534, issued by this company. The generator complete is shown, and large illustrations are also given of the armature, field coils, and other parts of the generator. There are also two pages of tables which will be of interest to those of our readers concerned in electrical matters.

The acetylene gas apparatus and accessories manufactured by J. B. Colt & Co., 3 West 29th St., New York, have a special catalogue of over 50 pages devoted to them. The text is very complete, and many illustrations are given. The various types of machines are shown, and large line drawings still further complete the work. These machines are made in all sizes, from small ones for yachts up to large ones for large vessels and buildings.

"Some Recent Installations of Worthington Condensing apparatus" is the title to the most recent publication of H. R. Worthington, Van Brunt St., Brooklyn, N. Y. The booklet is made up mostly of full page illustrations, each picture having a brief description of the subject illustrated. Among the vessels which have fine illustrations are the new battleship *Kearsarge*, the Pennsylvania R. R. ferryboat *Pittsburg*, and the new steamship *Havana*.

Marine plumbing receives very thorough consideration in a large and very complete catalogue issued by the J. L. Mott Iron Works, Marine Department, 84-90 Beekman St., New York. The thoroughness with which the subject is covered can be readily seen when it is stated that the last picture or plate in the catalogue is numbered 1,130. The printing and general make-up of the catalogue are of high quality, and altogether it is by far the most complete catalogue we have seen for a long time. It should be in the hands of every shipbuilder in the country.

Fireproofed Wood.—There is a great difference in the way in which fireproof wood seems to have been looked upon by the merchant marine and the Navy Department. A list recently published of war vessels in which this wood is used shows that there are eight battleships, nine gunboats, twenty-five torpedo boats and sixteen torpedo boat destroyers, together with monitors and cruisers. The Navy Department recently made very exhaustive tests of wood of this kind, and in his report to Secretary Long, Naval Constructor Zahn said: "As to the fireproof qualities of the samples tested, the electric fireproofed wood unquestionably shows a superiority over its competitors in the record of tests. Finally, therefore, the result of laboratory experiments, aside from the question of electrical resistance, which represents a property in no way involved in the use of the material, seems to me undoubtedly to warrant the following conclusions: That, so far as is known, there is no better process of fireproofing wood in use than that now employed by the Electric Fireproofing Company, and its continued use, for the present, at least, is advised." In Europe non-inflammable wood is used in most of the Navies, and the recent yacht built for Queen Victoria is fitted throughout with this wood. The Electric Fire Proofing Co., which has furnished wood for naval vessels and for many fireproof buildings, has offices at 119 West 23d St., New York.

BUSINESS NOTES.

Bloomsburg Jets and Circulators.—Owing to the demand on the Pacific coast for their steam jets and equilibrium circulators, H. Bloomsburg & Co., Newport News, Va., have established two agencies, Samuel Sutton, 329 Warren Ave., Seattle Wash., and Edwin W. Tucker, 130 Main St., San Francisco, Cal. This firm reports business as exceptionally encouraging, especially so on the Pacific coast.

Launch & Yacht Building.—Owing to the great demand there is for launches and yachts, the firm of C. B. Mather & Co., Lock Box 47, Rowley, Mass., has increased the capacity of its establishment very materially, and is now ready to build launches and yachts of any size. This firm has equipped its plant with all the latest improved tools, and has every facility for turning out good quality of work without any delay.

Berth Fittings.—The matter of fitting up berths on vessels of all kinds is an important one, and is receiving more careful attention each year. Among the concerns which have given special attention to this subject is the Hartford Woven Wire Mattress Co., 618 Capitol Ave., Hartford, Conn., which contract complete fittings, either in metal or wood, and with woven wire spring or national link mattresses. These fittings are furnished to any size. As this company has made a specialty of this line of business it is in shape to fill all orders promptly.

Electric and Acetylene Search Lights.—The Carlisle & Finch Co., Cincinnati, Ohio, reports business as excellent. The demand for its search lights and marine projectors is greater than ever. Many of the finest steamers on the western rivers and Great Lakes have adopted these search lights, and the U. S. Navy has placed several on the new torpedo craft. The company is in correspondence with the Japanese Government in regard to furnishing the new type of hand controlled projectors for use in the new Japanese land defenses. Besides making electric search lights this company has placed a line of acetylene search lights on the market. These search lights are used on launches and other small craft too small to use an electric search light. They are capable of picking out objects at 1,000 ft. distance with ease. The electric search lights and projectors of this company's manufacture have very long range, and are easily handled and taken care of. The fine new steamer *Pennsylvania* of the E. & B. Line on Lake Erie, was equipped with a large deck pipe projector in the spring, and the owners write as follows: "The light has been in use since May 26 and has given perfect satisfaction. All the claims you make for it are fulfilled by its action."

METALLIC PACKING.—In order to demonstrate the many uses in marine work for which its packing is particularly adapted the U. S. Metallic Packing Co., 13th and Noble Sts., Philadelphia, Pa., has had made some of the finest engravings that can be procured. Each month a change will be made in this company's advertisement, showing the different uses of the packing and the attention of engineers and others interested in the subject is called to the cut used this month, showing the manner in which one type of this packing can be applied to use on an old gland. More detailed information regarding this packing and its uses can be had from the company, and all readers who have not seen the very handsome catalogue recently published, and which was noticed in these columns last month, should send for a copy. Among the recent vessels to be fitted with U. S. packing is the transport *Thomas*, which has been undergoing alterations at the Cramp shipyard.

LARGE ORDER FOR BRASS TUBING.—Among the recent export orders reported is one of 30,000 lbs. of seamless drawn condenser tubes to Glasgow, Scotland, by Merchant & Co., Philadelphia, Pa.

AUTOMATIC WEIGHING MACHINES.—The automatic weighing machines formerly sold by the Pratt & Whitney Co. will hereafter be handled by the New England Automatic Weighing Machine Co., 56 Pearl St., Boston, Mass. The new company will manufacture the machines and attend to all matters connected with selling them.

POCKET ELECTRIC LIGHT.—The pocket safety electric light which is advertised elsewhere by James S. Barron & Co., 24-30 Hudson St., New York, has been found to be very useful on board ships, and the firm reports many sales in this direction. This light is especially valuable for purposes where a safe and handy flash light is deisred. There are no wires to get out of order, no chemicals to spill, and the light can be used in a hold full of gases, in an oil tank, and even in a powder magazine.

SPECIALIZING IN TOOL WORK.—The L. S. Starrett Co., Athol, Mass., has experienced such a demand for its fine mechanical tools that it has decided to discontinue the manufacture of milling cutters, etc., and has sold the entire stock, machinery and good will of the cutter department to Gay & Ward, who have been connected with the company for many years, and who will continue to carry on the business in Athol. The Starrett Co. will devote its energies exclusively hereafter to the fine tool business in which it has made such a reputation.

SHEET METAL SAFETY BOATS.—A line of sheet metal safety boats is offered by W. H. Mullins, Salem, Ohio. These boats are stamped and embossed, and being in one piece of metal are very staunch. They can be exposed to the weather for months at a time without being rendered unseaworthy. Each boat has a large air chamber in the end sufficient in size to float four men on an upturned boat should there happen to be a capsize. The price of these boats is very reasonable, but is regulated by the metal used, whether galvanized steel, manganese bronze or aluminum. These boats are made for such purposes as yacht tenders, pleasure and hunting boats, etc.

A SPLENDID BUSINESS SHOWING.—The Armstrong Manufacturing Company, Bridgeport, Conn., has found that its business increases so rapidly that another addition to the facilities has been found necessary. This is the second increase since January 1 last. Much new machinery is now being added to the works, and the company has built a large fire-proof warehouse to which the shipping department has been transferred. All orders for the company's goods can now be filled promptly. An increase of 30 per cent. of the export business within the past few months is reported. No less than $125,000 worth of pipe threading machines has been exported to Germany since the beginning of the year.

Electric Heaters for the Oceanic.—We are informed that the Simplex Electrical Co., 10 Franklin St., Cambridgeport, Mass., furnished a line of electric heaters for the new monster steamship *Oceanic*. They included heaters for cabins, hot water heaters, curling iron heaters, etc.

Improved Pipe Cutters.—Engineers will appreciate the improved three-wheel pipe cutters which are advertised by the Barnes Tool Co., 962 Grand Ave., New Haven, Conn. These pipe cutters are made in various sizes to cut from 1-8 in. up to 12 in. pipe, and have come into very general use among many steamship lines.

To Fill up Checks and Cracks.—Those in charge of vessels and yachts who have pride in the appearance of things will be interested in the elastic steam composition manufactured by Cole & Kuhls, foot of 26th St., Brooklyn, N. Y. This composition is made for the special purpose of filling up checks and seams, and is equally well adapted for masts, yards, booms, rails, etc.

Acetylene Lights.—J. B. Colt & Co., 3 West Twenty-ninth street, New York, are devoting their attention especially to their "Criterion" acetylene gas generators, sixty of which are said to have been just shipped abroad. The "Criterion" meets the approval of fire insurance underwriters, thus making it a desirable machine to use. A special searchlight is made to use in connection with it.

Pratt & Whitney's New York Office.—Mr. J. W. Cregar, who established a large machine tool business with headquarters in the Machinery Department of The Bourse, Philadelphia, Pa., has been appointed to the management of the New York office of the Pratt & Whitney Co., with headquarters on Liberty street, corner of Greenwich. The Philadelphia business will be continued in charge of Mr. L. E. Beaman.

Free Sample of Polish.—John M. Watt's Sons, 136 Liberty St., New York, have recently put on the market the Keystone metal polish, and it has been so popular in the marine field that the company offers to send a full sample box to any engineer who will write for it in order to still further introduce it. The claim is made that it polishes all metals, and that it is especially adapted for hot or cold steel or brass.

A Convenient Out Door Lamp.—Attention is called to the lamp advertised by the Rochester Lamp Co., 38 Park Place, New York, which is designed especially for shipyards, wharf buildings and other such uses. The lamp is sold complete with post socket, and has an outside time regulator which permits the flame being regulated to burn any number of hours according to whatever use is made of the indicator. This self-extinguishing device is very simple and will be appreciated.

ZINC WHITE IN MARINE PAINTING.

Within a few years after the discovery of the modern process for making zinc white, the French naval authorities, after severe tests, ordered its use to the exclusion of white lead on the interior of all vessels of the French navy. Experience has confirmed its superiority for painting structures exposed to sea-air and sea-water, and the French navy as well as the French steamship companies now universally employ it, while it is also the official base for painting lighthouses and Government work on the seashore. The French marine authorities also use it for painting galvanized iron plates, the hulls of torpedo boats, the shells of metal pontoons, etc.

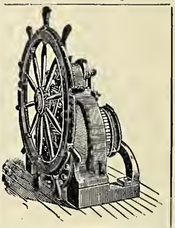
That the French navy should have been earliest to adopt this practice is natural, since zinc white was first generally introduced in France. But the naval authorities of the United States, having made their own experiments with the same results, have adopted zinc white as the fixed component of all paints used either in the Navy or by the Lighthouse Establishment. The famous "White Squadron" obtained its color from zinc white, and remained white because zinc does not change color. Ten tons of American zinc white is the cruising allotment for each ship, and it is used liberally and effectively.

Similar testimony is found in the U. S. Lighthouse specifications, which require, for white, a mixture of one-fourth lead and three-fourths zinc, and for tinted paints, American zinc white and yellow ochre, with no lead. "The colored paints are wanted for outside use and are required to withstand the bleaching effects of salt water and sunlight."

The durability of zinc white is due to its chemical stability and to the large proportion of oil it carries to the painted surface. No other white pigment approaches it in this respect. It is the one white paint material that is capable of resisting salt water and salt air. Added to other materials it shields them and gives them durability.

Advt. NEW JERSEY ZINC CO.

Queen City Patent Hydraulic Steerer.

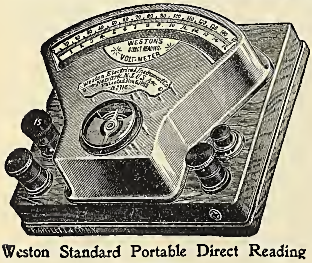


THE BEST AND MOST RELIABLE.
GENERATES NO HEAT IN PILOT HOUSE.

Has Large Hand Wheel.
Can be Changed from Power to Hand Steering Instantly.
A Favorite with Pilots.

SEND FOR REFERENCES.

QUEEN CITY ENGINEERING CO.,
BUFFALO, N. Y.



Weston Standard Portable Direct Reading Voltmeter.

WESTON STANDARD PORTABLE

DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as **THE STANDARD** the world over. Our **VOLTMETERS** and **AMMETERS** are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.

REMOVAL OF HEADQUARTERS.—Larger and more commodious quarters have been taken by the Great Lakes Register so that the Cleveland office is now Rooms 406 and 407, Perry-Payne Building. With the new facilities this insurance company can give the promptest attention to all calls for plans, specifications, estimates, or for advice in matters of mechanical engineering, surveys of marine property or adjustment of losses.

BARR PUMPS.—The annual report of the water department of the city of Waltham, Mass., refers in very high terms to the Barr pumping engines with which the power house is equipped. The steam plant has on its main steam pipe the McLaughlin safety valve, by which steam is instantly shut off from the engines automatically in case of accident. Although used on a stationary plant this valve was designed particularly for marine work. The Barr Pumping Engine Co., Germantown Junction, Philadelphia, Pa., can give full details.

LAUNCH OF THE MARACAIBO.—On August 24 the Harlan & Hollingsworth Co., Wilmington, Del., launched the new freight and passenger steamer for the Red D Line, Boulton, Bliss & Dallett, of New York, agents. The *Maracaibo* was christened by Miss Mary Dallas, daughter of J. T. Dallas, superintending engineer of the line. The *Maracaibo* is 277 ft. 6 in. long over all; 266 ft. between perpendiculars; 37 ft. beam moulded, and is built to carry 800 gross tons on 10 ft. draught, with accommodations for about 100 passengers. She has seven water tight bulkheads, two steel masts and tank capacity of 200 tons. She is propelled by two triple expansion engines supplied with steam by two Scotch boilers. Immediately after the launching a new coastwise ship for the Metropolitan Steamship Co., of New York, was laid down. The *Maracaibo* is the fifth ship launched by the Harlan & Hollingsworth Co., since the beginning of the year and she will probably be followed next month by the second ship for the N. Y. & Porto Rico Steamship Co., to be called the *San Juan*. The *Ponce*, which was launched last month, will probably have her trial trip and delivery some time during this month, as will also the torpedo boat *Stringham*, which is nearly completed. The Harlan & Hollingsworth Co. has just contracted for three large tugs for the Pennsylvania Railroad Co., and these together with the two ships building for the New York & Baltimore Trans. Line, the steamer for the Winsor Line, and the two torpedo boat destroyers *Hopkins* and *Hull* make an extremely busy yard, to say nothing of the many ships at the wharves undergoing repairs, together with the large amount of car work on hand.

TRADE PUBLICATIONS.

Users of electric motors will be interested in the latest bulletin issued by the Bullock Electric Mfg. Co., Cincinnati, Ohio, which describes in considerable detail and illustrates fully the manner in which Bullock Motors are direct connected to machines.

A neat pocket size catalogue, of 8 pages and cover, has been issued by the Racine Hardware Co., Racine, Wis., describing briefly and illustrating with unusual neatness this company's high grade automatic vertical engines, both alone and direct connected, for electrical work. These engines are designed especially for marine lighting sets, and the catalogue will be of much interest to many of our readers.

A new price list and pocket catalogue of the steam specialties manufactured by the George M. Davis Regulator Co., 96-110 North Clinton St., Chicago, Ill., is now ready for distribution. This catalogue is printed in red and black, is very well illustrated, and describes in much detail each of the specialties, which include pressure regulators, back pressure valves, steam traps, pump governors, and valves of several types.

Jewell electrical measuring instruments, for direct current only, have a neat pocket size catalogue of 8 pages printed in two colors devoted to them by the manufacturers, the McIntosh Battery and Optical Co., 521 Wabash Ave., Chicago, Ill. The claims made for these instruments are that they are durable and accurate, and that their construction is exceedingly rigid, making it possible for them to withstand rough usage.

Direct connected generators have an 8-page catalogue devoted to them by the Triumph Electric Co., Cincinnati, Ohio. The generators are illustrated and the different parts fully described, and several types of direct connected plants are shown direct connected to several makes of engines. These sets are made from 1 K.W. to 17 1-2 K.W. Copies of the catalogue can be had from the company by referring to MARINE ENGINEERING.

The compartment system on ships known as the "Long-Arm" system of water-tight doors and hatches operated by a central station, is fully illustrated in a pamphlet just issued. Many illustrations are given showing how this system was applied to the protected cruiser *Chicago* when recently rebuilt. The illustrations in the pamphlet are exceptionally complete. It is issued by the Long-Arm System Co., Garfield Building, Cleveland, Ohio.

Pumping machinery of the Deming Co., Salem, Ohio, has a new catalogue (E), which is just published. The power pumps which are described are in great variety of design, for all sorts of uses, and these pumps are designed to give the greatest efficiency, and are made heavy enough to withstand the hardest of usage. Each type of pump is very fully illustrated, and a great deal of interesting matter regarding the use of pumps is given.

Dixon's graphite products are fully described and very completely illustrated in a 62-page catalogue just issued by the manufacturers, the Joseph Dixon Crucible Co., Jersey City, N. J. This is a book of reference which should be in every office, especially because of the variey of subjects covered. These include lubricating graphite in several forms, the illustrations showing the different ways in which this lubricant is put up for the market, and giving much detail in the text as to the different uses of it. The silica-graphite paint is given the same thorough attention, and the many illustrations make the subject very interesting. Other subjects are: Crucibles of many forms, brazing graphite, and pencils of all kinds. This last department of the catalogue is very complete, and is thoroughly illustrated, showing innumerable sizes and kinds, and the manner in which these, with other draughtsmen's and desk supplies are furnished for the market.

Rope and rope-making is told about in a very instructive manner in a catalogue issued by the Waterbury Rope Co., 69 South St., New York. The catalogue gives an account of the manner in which the material from which rope is made is gathered, and follows the process of manufacture. In addition there is a good deal of valuable information regarding rope which every marine man ought to have handy in the form of this catalogue.

"Steel Plate Planing Mill Exhausters" is the latest catalogue issued by the B. F. Sturtevant Co., Jamaica Plain, Mass. Shipbuilders and others who have woodworking establishments in which shavings, sawdust and other refuse from wood-working machinery are not only a nuisance but a source of danger by fire, will be much interested in this catalogue, as the apparatus described is designed for the special purpose of removing this refuse at the least expense possible. The catalogue is very neatly printed and fully illustrated.

Users of lubricants will want to send for a copy of the catalogue just issued by W. J. Schaefer & Co., 33 Barclay St., New York, who make a specialty of lubricating oils and greases, together with machinists' and engineers' supplies, etc. The catalogue describes in considerable detail the various lines of lubricants which this firm handles, including several kinds of special marine oils. Considerable reference is also made to the different kinds of grease which this firm sells. Copies of the catalogue can be had from the company upon application.

Granite rock wool sectional pipe and boiler covering has a neat catalogue devoted to it, issued by the manufacturers of this material, the American Insulating Material Mfg. Co., 213 North Third St., St. Louis, Mo. Many illustrations are given showing the application of this wool, and enough descriptive matter is added to make the pamphlet very interesting. For fire protective uses special claims are made, as it is said that 4,000 degrees of heat are required to produce the wool. A special form of the wool is used for ammonia and brine pipe covering.

The Johnson rotary pump is very carefully illustrated and described in a catalogue issued by the Davis-Johnson Co., 41 West Randolph St., Chicago, Ill. Although a rotary pump, this pump differs quite materially from the ordinary centrifugal pump, and these differences are fully shown in the illustrations, which give sectional views, as well as exterior views. of the different parts. The special features of the pump are emphasized; such as there being no valves to get out of order, and its compactness. The pump can be used direct connected to a steam engine or electric motor, or, if desired, can be run by a belt. One practical and novel use for the pump is shown as having it mounted on a truck, making it portable, as it is direct connected to a gas engine, so that the outfit can be used for fire or drainage purposes, as well as ordinary pumping. The compactness of the pump, together with its durability, makes it desirable for many uses in the marine field.

Mechanical ventilating appliances manufactured by Howard & Morse, 45 Fulton St., New York, include the Blackman power ventilator wheel and the patent high speed Solano steam engine. The special feature emphasized, in a new catalogue, in the ventilating wheel is an end bucket by means of which the wheel takes in air at right angles to, as well as parallel with, its shaft. Very great efficiency is claimed because of this, and the fan especially, by the makers for holds, engine-rooms, etc. The claim is made that by means of this wheel air can be moved at the rate of 16,000 cu. ft. per minute for each actual horse power employed. The illustrations in the catalogue show the wheel to much advantage, and many tables are given, adding to the value of the catalogue. Several pictures are also given showing the Solano engine direct connected to the fans; also, direct connected to electric motors. The engine is described in considerable detail and illustrated with sectional views.

Draughtsmen will find a catalogue of great value in the one which has just been issued by the F. W. Emerson Mfg. Co., Rochester, N. Y. It is a very handsome catalogue of about 50 pages, printed unusually well and bound in a dark-green cover, with green and gold lettering and decorating. Almost everything needed in the line of draughting-room furniture is illustrated, including draughting tables of all sizes, blue printing frames and apparatus for exposing them, filing cabinets and other appliances for simplifying and facilitating the work in draughting-rooms. A copy of this catalogue should be in every office where drawing of any kind is done.

Fine tools, machinists' hardware, brass and copper in all forms, and many other specialties of the Charles H. Besly Co., 10-12 North Canal St., Chicago, Ill., have a very complete catalogue devoted to them, which is just issued. Copies of this any of our readers can have from the company by mentioning Marine Engineering. The 300 pages of the catalogue are closely printed and very profusely illustrated, forming a complete reference list for engineers and others who have use for small tools. No more complete catalogue has ever come to this office, and judging by the appearance of it every article in the line of tools is illustrated and referred to. Draughtsmen will also find everything that could be asked for in this catalogue.

"Making Records" is the latest pamphlet issued by the Joseph Dixon Crucible Co., Jersey City, N. J. It refers primarily to the successes attained by Dixon pure flake graphite on locomotives, but we presume the same story would apply to marine engines as well. The book is a practical description of the subject of lubrication, and gives much information that any engineer would be glad to have. Special emphasis is laid upon the fact that graphite is "smoother" than any known material, and is a good conductor of heat and electricity. Acids and alkali will not act upon it, and it will resist a degree of heat that will liquefy nickel. This is stated to be the secret of graphite for reducing friction. The book is an experience meeting of what many users of graphite lubricants have to say, and comprises about 32 pages.

No catalogue ever received at this office is a finer specimen of the printer's art than that just issued by the Westinghouse Machine Co., Pittsburg, Pa., descriptive of the Westinghouse gas engines. The cover is of heavy red paper, neatly embossed and printed in two colors, and the 68 pages of contents are beautifully printed on fine, heavy paper and illustrated with many handsome engravings. Many pictures show both the engines themselves, and the different uses to which they have been put, especially for direct connected electric work. The text is very complete, and the features of the engine are illustrated and described separately. Much interest will be attached to the description of the 650 H.P. three cylinder gas engine with which the catalogue opens. The catalogue is very complete, and the Westinghouse companies are certainly to be congratulated upon it.

Eclipse reducing valves and other steam specialties manufactured by The John Davis Co., 51-79 Michigan St., Chicago, Ill., have an exceptionally attractive and beautifully printed catalogue devoted to them. The paper is heavy and finely coated; the illustrations are exceptionally clear and well made, and the printing is in red and black, giving a very neat effect. The marine pressure regulating valve is shown in the advertisement of this company elsewhere in this issue. This valve is made of a high quality of metal, and is guaranteed not to cut at 250 lbs. pressure. There are no diaphragms to break, and no stuffing boxes or dash pots to be packed or kept clean. Other specialties are automatic water and air regulators, regulating valves for reducing pressure, pump regulators, blow off valves, separators, steam traps, safety water columns, boiler feeders, etc. The catalogue is valuable both as a book of reference and as a sample of exceptionally fine printing.

BUSINESS NOTES.

Chicago Nautical School.—The winter session of the Chicago Nautical School opened October 1. The school starts its sessions with pupils from the Atlantic coast, and one from Texas. A sailor on the Pacific coast has signified his intention of joining the school at a later date, taking the nautical course by mail.

The Lockwood Co.—The Lockwood Co., East Boston, Mass., was very busy last month with repair work. The steam yacht *Avenel* was up for repairs to her engines and propeller wheels; a tramp steamer was having her pumps and steering gear overhauled; three tugs were having their machinery fixed up, and the Kennebec steamer *Sagadehoc* was having her boilers and engines overhauled.

"Brotherhood" Overalls.—Attention is called to the advertisement of H. S. Peters, Dover, N. J., who makes a specialty of overalls for Marine Engineers. Mr. Peters himself is an old engineer, and his overalls are made as the result of his own experiences, and they are called "Brotherhood' from his connection with the Brotherhood of Locomotive Engineers. An important feature of these clothes is the patent safety watch pocket on the coats, which alone is believed to be worth more than a whole suit of ordinary over clothes. All garments are sold under a guarantee that if any garment gives just cause for complaint in any respect it will be replaced free of all charge.

Fitting Propellers to Boats.—In selling his propeller wheels H. G. Trout, of the King Iron Works, 226 Ohio St., Buffalo, N. Y., issues a series of questions which, if properly answered, make it possible to build a propeller which shall suit the special needs of any vessel. These questions include a general description of the lines of the boat and a considerable amount of information regarding the machines; also, the important question of what it is desired that the wheel shall accomplish. By this means a propeller can readily be adapted to the work required, and those of our readers interested in the subject of propellers will do well to send to Mr. Trout for this series of questions when they are in the market for propellers.

Valve Reseating Machines.—The Leavitt Machine Co., Orange, Mass., had at the National Convention of the National Association of Stationary Engineers, held early in September at St. Louis, Mo., one of the best exhibits of the Morse & Dexter valve reseating machine that they have ever given, comprising a full line of machines embracing their 3, 4, 6, 9 and 12 outfits. The exhibit was in charge of their general agent, Mr. A. C. Ricksecker, who wrote his firm that they had the finest exhibit at the Convention, and one that commanded the greatest attention of all the engineers. The company was also informed that they had one of the best souvenirs at the Convention, which was an outside and inside caliper combined. A delegate to the Convention also wrote the company, unsolicited, facts practically as above.

DESPATCH STEAMER LAUNCHED.—Last month the R. M. Spedden Co., Baltimore, Md., launched the steel despatch steamer *General Hunt,* which is being built for the United States Engineers. The new steamer is 95 ft. long, and she will make a speed of about 13 knots.

BULLOCK ELECTRIC APPARATUS.—The great shops of the Bullock Electric Mfg. Co., Cincinnati, Ohio, have been crowded with orders for many months past, and during the past month orders have been filled, not only from all parts of the United States, but from Great Britain and elsewhere across the water, the machines ranging in size from 2 1-2 K.W. to 800 K.W. capacity.

WATER-TUBE BOILERS.—Owing to the greatly increased demand for its products, the Sterling Co., Pullman Building, Chicago, Ill., has found it necessary to increase the facility of its boiler plant very materially. A building 60 by 100 ft. will be erected as a foundry, and a machine and equipping shop, 60 by 182 ft., is being built for the marine department, and several other buildings are being constructed. Our readers will remember that the Sterling Co. manufacture the Niclausse and other types of water-tube boilers.

CLOSET FLUSHING DEVICE.—An ingenious little mechanical appliance for flushing water closets is the Kenney "Flushometer," which effectually dispenses with the noisy and dirty overhead tank. In competition with other devices for the same purpose it has been approved by William Cramp & Sons, Philadelphia, Pa., and the Morse Iron Works, New York. The former installed 77 of these "flushometers" on the U. S. transport *Thomas*, and the latter firm installed 60 on the U. S. transport *Logan*. The manufacturers of this device are the Kenney Co., 72-74 Trinity Place, New York.

PYRO PAINT.—The protection of iron and steel from corrosion is of importance to marine people, and undoubtedly many of our readers will be interested in the claims set forth by the Shearer-Peters Paint Co., Cincinnati, Ohio, for their Pyro paint. The claim is made that it stays the progress of corrosion, and makes an outer surface through which no destructive element can gain access. The paint hardens to the consistency of vulcanized rubber under favorable drying conditions in about 50 hours, and it will stand a large amount of heat before being affected. "It is water, rust, rot, acid, alkali, potash, salt water, worm, insect and barnacle proof," says the catalogue. A letter is published from Joseph King, with the Merchants' & Mariners' Transportation Co., in which he says: "The wooden boat-bottom you painted for me ten months ago has given wonderful satisfaction. Before being painted with your Pyro paint the bottom of my boat would befoul so much in the water that the barnacles and other foreign substances had to be scraped off every five or six weeks, but since the application of your paint this has not been necessary at any time. I consider your paint a wonder on account of its lasting quality under salt water, and the protection it affords against barnacles, worms, etc."

NEW GAS ENGINE.—The Cooley Mfg. Co., Waterbury, Vt., has recently designed a gas engine for marine uses, and has installed one in a launch which is just being tested on Lake Champlain.

YACHT BLOCKS.—The blocks for the steam yacht *Virginia*, which was illustrated and described in the September number of MARINE ENGINEERING, were built by J. S. Jackson & Son, Bath, Me., who make a specialty of blocks for fine yacht work.

TAUNTON YACHT WORKS.—Brown's Boatyard at Taunton, Mass., has recently been purchased by Messrs. A. Loring Swazey and Arthur Raymond, who will enlarge the yard and put in machinery for building yachts and launches of all kinds. The new concern will be known as the Taunton Yacht Works, and will be ready for business in time for the coming season. Mr. Brown will continue to have immediate supervision of the business.

NEW YACHT BUILDING CONCERN.—A company has been organized at Clayton, N. Y., to build launches and yachts, known as the St. Lawrence Boat Co. The company is organized with a capital stock of $40,000, and has fitted up a large plant with every facility for building launches and yachts of almost any size.

BOAT WORKS DESTROYED.—The Truscott Boat Mfg. Co., St. Joseph, Mich., was most unfortunate last month to have a fire which destroyed the larger part of its establishment. This company started in six years ago in a little shop down on the lake front at St. Joseph, scarcely large enough to hold a half dozen boats, and has prospered to such an extent that it recently purchased a large factory, and was only recently employing 250 mechanics. Fortunately, three large warehouses which were nearly filled with launches or engines, either completed or in some degree of completion, escaped destruction. The company will rebuild at once, and there will be but little, if any, interruption in its business.

Correspondence Instruction.—A feature of the National Export Exposition at Philadelphia is an exhibit by the International Correspondence Schools, Scranton, Pa., illustrating their method of teaching by mail. The bound volumes of their instruction and question papers, as well as work done by students, including numerous drawing plates, may be inspected by visitors, and a representative will be in charge to give full particulars.

Anchor Works Burned.—The large building of the Cape Ann Anchor Works at Gloucester, Mass., was completely destroyed by fire last month, causing a large loss, not only in buildings and stock, but in business, as the company was four months behind in its orders. It is understood that the plant will be rebuilt immediately and business resumed as soon as possible. The company has been in business 19 years, and has made a reputation for its anchors and forgings.

Switch Board.—Those of our readers interested in electricity may be interested in the line of switch boards manufactured by the Crouse-Hinds Electric Co., Syracuse, N. Y. This company makes a specialty of building switch boards and all the attachments that go to make them complete. These include everything from large double-break switch to the ordinary single-break switches, and they are built for both high and low tension. This company also furnishes the panel boards and boxes, and all the other parts that go to make an installation complete.

Patent Leak Arrester.—A device for making temporary repairs in the hulls of ships wherever a plate is punctured or rent is being put on the market by Ostheimer Bros., 621 Broadway, New York, and 900 Chestnut St., Philadelphia, Pa. It is called the Colomes stopper. During the recent Spanish war it was used on the *Iowa*, and in writing of the incident an eye-witness says: "A shell struck our starboard bow, about one foot above the waterline. It went through the coffer dam, struck a steel hatch, and burst. It started a fire, which was quickly put out. The deck was flooded, but a patent stopper was put in and we were as good as ever." In closing a hole one of the stoppers corresponding approximately to the size of the hole is taken from the case, relieved of its cellulose bag, and thrust through the hole. As soon as it is thrust through it is given half a turn, securing it in place. It is at once pressed closely up against the outside plating of the hull by the inrushing water, where the brass plate serves to cover the hole and partially stop the flow of water. The cellulose pad, the steel washer and the nut are then slipped over the inboard end of the rod, and the nut is screwed home, pressing the bag closely against the hole and sealing the opening. The cellulose bag fits into all the irregularities of a jagged hole, and the powerful pressure of the nut, aided by swelling effect of the water on the cellulose, insures a tight closing of the hole. In cases of collision it more often than not happens that the hole is long and narrow. Such holes may be closed by using several stoppers side by side.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

A Solid Engine.—Those of our readers interested in the subject of marine engines will notice the one illustrated in the advertisement of the Sheriffs Mfg. Co., Milwaukee, Wis. This is the type of engine manufactured by this company, and the one photographed was built for the tug *W. H. Meyer*. It is 14 by 22 1-2 by 36 in., with 30 in. stroke. It makes 150 turns a minute under a steam pressure of 185 lbs. The wheel is 9 ft., with a 10 ft. pitch.

Boiler Staybolts.—A test was recently made of the staybolts manufactured by the Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio, by the Pittsburg Testing Laboratory. The report was as follows: Dimension, 1.035; area, .1879; elastic limit, 30,600 lbs.; maximum load, 47,700 lbs.; tensile strength per sq. in., 28.320. The safety hollow steel staybolt which is being manufactured by this company for marine boilers fulfills all the Government requirements, and is now used by many boiler builders.

A New Cure for "that tired feeling."

A good sleep is better than medicine any time. Nearly everyone has learned of the **OSTERMOOR PATENT ELASTIC FELT MATTRESS,** which we deliver anywhere for **$15,** let you try it for 30 nights, and then offer to give you your money back if it does not equal in cleanliness, durability and comfort any $50 *Hair* Mattress you have ever tried.

We can't tell you all about it here; we can't quote the hundreds of letters from people of prominence who have used them for as long as 20 years without impairment; but we have just issued a new illustrated edition of our book, **"The Test of Time,"** which we will mail to any one interested upon application. If you don't need a mattress this year you may next—and it's always well "to know."

Patent Elastic Felt consists of airy, interlacing, fibrous sheets of snowy whiteness and great elasticity; closed in the tick by hand, and *never* mats, loses shapo or gets lumpy. Is perfectly dry, non-absorbent, and is guaranteed vermin proof. Tick may be removed for washing without trouble. Softer and purer than hair *can be*; no re-picking or re-stuffing necessary,

Wretched imitations are offered by unscrupulous dealers — please write us if you know of such cases.

OSTERMOOR & CO.,
114 Elizabeth St., - - NEW YORK.

THE JOHNSON IRON WORKS, Limited, ENGINE, BOILER and MACHINE WORKS,

Shipyard, ALGIERS, LA. P. O. Drawer 241. NEW ORLEANS, LA.

Steel Lighters, Barges and Stern Wheel Steamers of moderate dimensions. Built in sections, when required, for convenience of transportation. Have just completed 20 Steel Lighters and 5 Stern Wheel Steamers, all sectional, which have been shipped from here by steamer and sailing vessel.

MORRIS & CUMINGS DREDGING CO.,

RIVER AND HARBOR IMPROVEMENTS,

17 State Street, NEW YORK.

Hydraulic Dredge discharging through 5,700 ft. Pipe. Will dig and put ashore any material. Rock excepted.

NEW YORK DREDGING COMPANY.

ENGINEERS AND CONTRACTORS.

J. WILLIAMS MACY, President. O. L. WILLIAMS, Secretary and Treasurer.

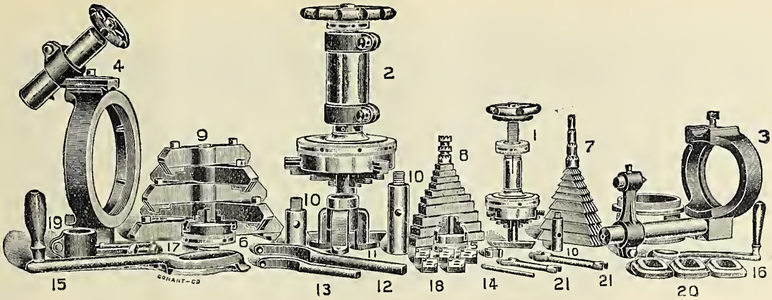
SPECIALTIES: Machinery for Economical Excavation of Canals, for Dredging, for Reclamation of Low Lands.

Machines at work at Wilmington, Del.; Port Royal, S. C.; Port Arthur, Sabine Pass, Texas and Oakland, Cal.

Correspondence solicited.

Capacity of plant owned by us, under favorable conditions, 1,000,000 cubic yards per month.

OFFICE: WORLD BUILDING, - - - - - - - NEW YOR K

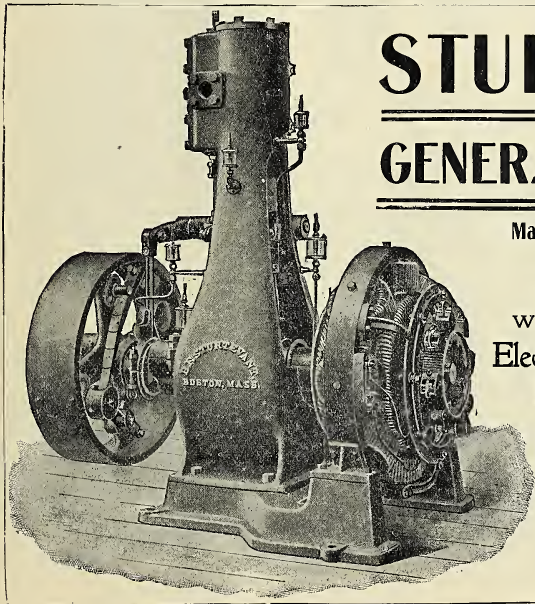


THE BEST ADVERTISERS

of the "Morse and Dexter" Valve Reseating Machine are the Engineers who use them. Hundreds, yes thousands, will testify that it is the handiest tool in their establishment and has paid for itself several times over. These machines are in use in two-thirds of the Breweries of the United States. The United States Government has adopted it for the Army and Navy Service; Mining plants in this country, Europe and South Africa are using these machines. We will take pleasure in referring intended purchasers to people they know in their locality who are using these machines.

THE LEAVITT MACHINE CO.,

ORANGE, MASS., U. S. A.



STURTEVANT

GENERATING SETS

Made in 8 styles and 50 sizes.

$1\frac{1}{2}$ to 100 K. W.

With Vertical and Horizontal Engines.

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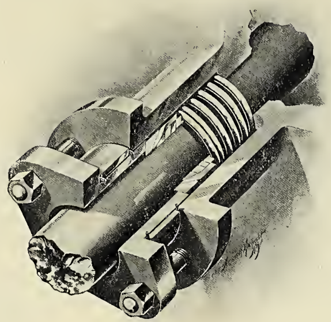

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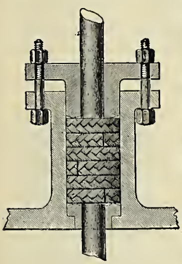

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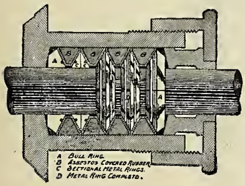

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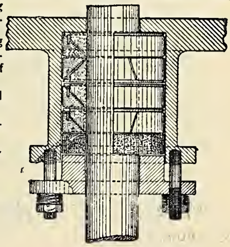

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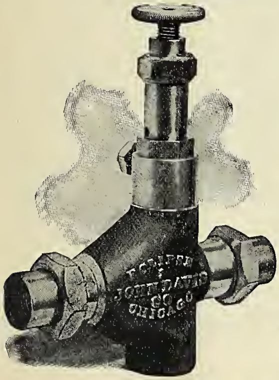

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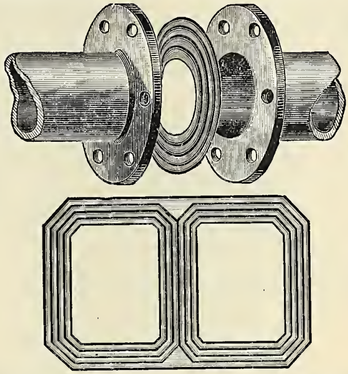

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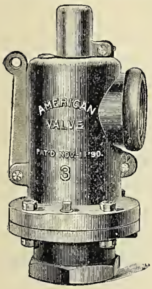

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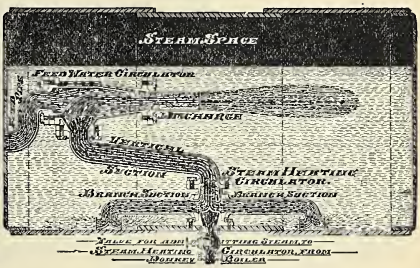

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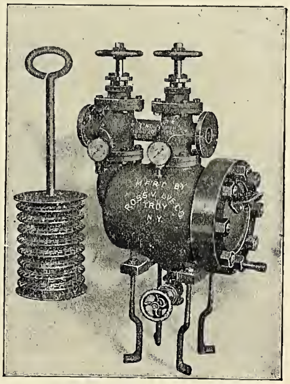

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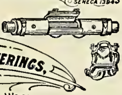

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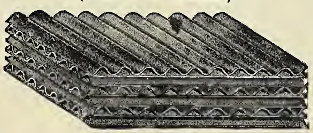

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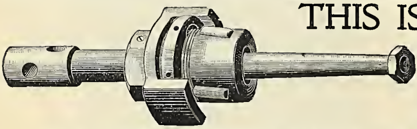

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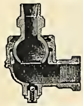

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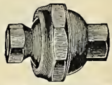

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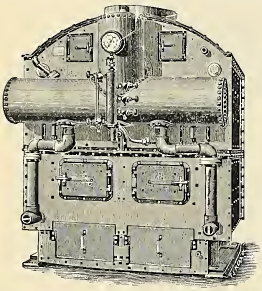

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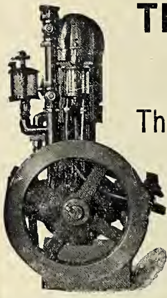

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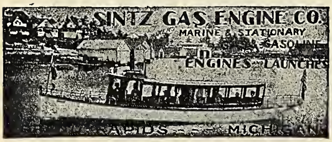

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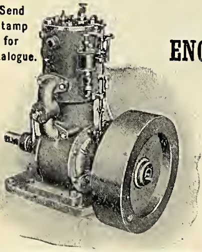

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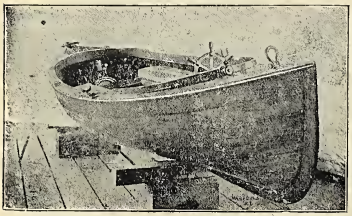

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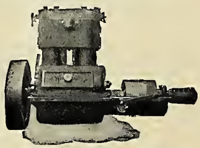

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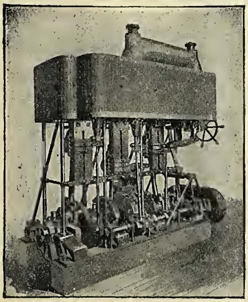

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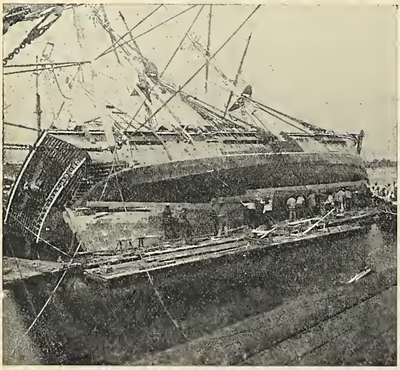

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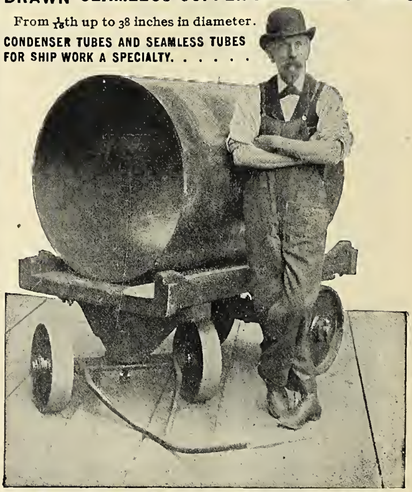

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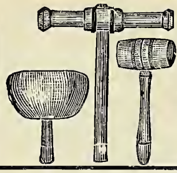

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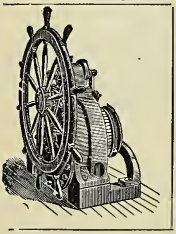

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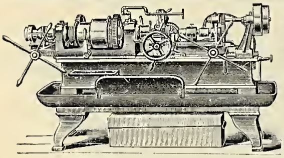

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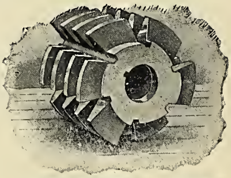

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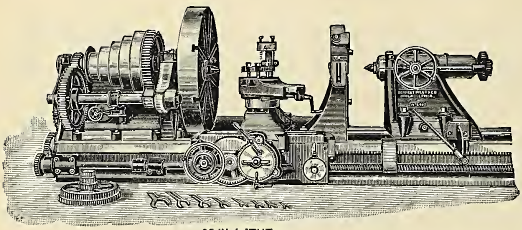

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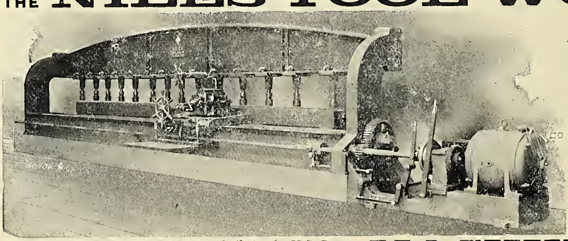
AGENCIES:

H. GLAENZER & PERREAUD, Paris.
G. DIECHMANN & SON, Berlin.
"ATALANTA" TECHNICAL AGENCY, St. Petersburg.
V. LOWENER, Copenhagen.
SHERRIFF, SWINGLEY & CO., Johannesburg.
WERNER HULT, Helsingfors, Finland.
VAN RIETSCHOTEN & HOUWENS, Rotterdam, Hol.



25 foot plate Planing Machine. No. 6118, built for the U.S. Government, in use at the Mare Island Navy Yard.

MACHINE TOOLS.

INDEX TO ADVERTISERS.

INDEX TO ADVERTISERS—*Continued.*

(*Index continued on page 40.*)

INDEX TO ADVERTISERS—*Continued.*

(Index continued on page 42.)

INDEX TO ADVERTISERS—*Concluded.*

An Information Bureau.

Owing to the many inquiries which are constantly being received asking for the addresses of manufacturers of materials, machinery and supplies, we have found it necessary to establish an Information Bureau, the services of which we take pleasure in placing at the disposal of our subscribers without charge.

Subscribers desiring information of this character will please address inquiries to

MARINE ENGINEERING
INFORMATION BUREAU,
WORLD BUILDING, - - - - NEW YORK.

VIEW LOOKING DOWN BROADWAY TO BATTERY PARK.

CHANGE OF LOCATION.

With the present issue the office of publication of MARINE ENGINEERING is changed from the World Building to 309 Broadway, corner of Duane street, New York. Those of our readers who reside in or visit New York are without doubt familiar with the situation of the building with the gilt dome—our former home. Its picturesque front in the more somber group of buildings that constitute Newspaper Row makes it a conspicuous object on land, and its dome outlined by electric lights at night makes it as familiar to those who sail on the neighboring waters.

In our new home the conditions are rather reversed. A huge skyscraper that does not differ materially from a dozen others on the best known thoroughfare in the civilized world is the place from which our efforts are now directed. Its identity is lost in a number, and it is not until the visitor gets inside that the superiority of our new location from a marine point of view is observed. By the aid of the engraving the reader can look down Broadway with us, past the Federal Building, the monster 34-story Park Row skyscraper on the left, and a thousand and one historical and interesting bits of New York, to the Battery, washed by the waters of the converging rivers. Again, he can look to the west and get a glimpse of the Hudson, where the finest ships of all nations are ever on view; and where it broadens out into the upper bay he will note the sentinel Statue of Liberty. When the view was taken the new marine monster, the *Oceanic*, was in sight, and some idea of her size is possible by comparison with near-by buildings and passing craft.

Three removes are reputed to be as bad as a fire, and our own experience is that two are as bad as a flood. Our readers and advertisers, by their plainly expressed support, have caused this visitation; but we are willing to endure so long as we can continue to merit their honest approval.

TRADE PUBLICATIONS.

Double Seated "Clip" Gate Valves is the subject of a four-page folder just issued by the Lunkenheimer Company, Cincinnati, Ohio. Several illustrations are given showing the different constructions, and the text fully describes the valves and gives price lists, sizes, etc.

Users of metallic packing will want to send for the booklet issued by the Holmes Metallic Packing Company, Wilkesbarre, Pa. Several types of stuffing boxes are illustrated, and the packing itself is described in quite a detailed manner. Many testimonials are also given from users of the packing speaking of it in the highest terms.

STATUE OF LIBERTY. S. S. OCEANIC, BOUND OUT.

The Eclipse pneumatic tools sold by W. J. Schaefer & Company, 33 Barclay street, New York, are well described in a catalogue received. Smaller tools for chipping and caulking are illustrated and fully described, and much information is given regarding them. Larger tools, such as rotary drills, etc., are also shown.

Graphite for cylinders and valves has a twenty page folder devoted to it just issued by the Joseph Dixon Crucible Company, Jersey City, N. J. The text is printed in green, and the many illustrations are in red. There is nothing particularly new in the catalogue, yet it brings into a compact form much valuable information on the subject of graphite lubrication.

"A Book of Success," issued by the International Correspondence Schools, Box 1111, Scranton, Pa., publishes many interesting communications from both men and women who have taken up instruction by correspondence in these schools and have secured good positions. One marine engineer says: "Since enrolling in your schools I have advanced from fireman to chief engineer of an ocean-going steamer."

Catalogue Number 6 has been issued by the Sherwood Manufacturing Company, Buffalo, N. Y., describing the many modern appliances for engines and boilers which it manufactures. These specialties include injectors, ejectors, oil pumps, oil cups, grease cups, lubricators, Niagara tube cleaners, flue cleaners, etc. The catalogue is fully illustrated and contains many tables and much other valuable information, and will be sent to all of our readers who write for a copy.

"Suggestions" is the title to the pamphlet printed in two colors, and bound in a cover of heavy blue paper printed in gold letters, issued by the Boston Belting Company, 256 Devonshire street, Boston, Mass. It gives much information regarding the subject of rubber, and the manner of gathering it is fully illustrated. This in itself makes the book well worth sending for, and in addition it gives a list of the many specialties manufactured by the Boston Belting Company and a list of agencies in various parts of the United States where rubber goods can be purchased.

The handsomest catalogue we have ever seen devoted to the subject of steamship and railroad specialties is just received from W. S. Laycock, Victoria Works, Sheffield, England. The book is 10 by 12 in. in size, and is bound in a heavy board cover, handsomely embossed and printed in two colors. Incidentally it is interesting to know that the embossing was done on this side of the water. Many large full page half-tone engravings of fine quality give an idea of what a large establishment the Victoria Works is, and the 78 pages of text are printed in two colors, giving a very rich effect. Nearly everything in the book refers to railroad, but there are several marine specialties, such as ships' berths, movable seats, patent window lifts, together with electric heaters and other heaters of various types, etc.

A souvenir of the eighteenth annual convention of the American Street Railway Association was issued by the Bethlehem Steel Company, South Bethlehem, Pa. It comprises over fifty very neatly printed and illustrated pages, and outside of the information regarding the convention it illustrates and describes many large power plants in which hollow forged fluid compressed steel shafts, which have been oil tempered and thoroughly annealed, are used.

Cooking and heating stoves manufactured by the Primus Company, 197 Fulton street, New York, are very fully illustrated and described in a catalogue recently issued. An important point regarding these stoves is that ordinary kerosene can be used and no wick is required, as the oil is vaporized for burning. It is claimed that over one million of these stoves have been sold. They are suited to all purposes where cooking or heating are required, and also for many industrial uses. They have been used extensively on yachts and other vessels.

A free memorandum book is sent to all inquirers by the New Jersey Paint Works, Wayne and Fremont streets, Jersey City, N. J. It is vest-pocket size and comprises many pages, also a calendar good up to October, 1900. References are made to the several kinds of paint manufactured by this establishment.

The Sprague Electric Company, 20 Broad street, New York, has issued a handy little book of instructions for the proper installation of flexible metallic conduit. Many illustrations of the conduit are given, and the text is sufficient to make the subject complete.

Seamless brass and copper tubes are well described in a little eight-page booklet, with cover, issued by Merchant & Company, Inc., 517 Arch street, Philadelphia, Pa. The printing is in red and black, and an amount of information is given which will be of much interest to users of such tubing.

Stop cocks, union couplings, and other specialties manufactured by the E. M. Dart Manufacturing Company, Providence, R. I., have a very neat catalogue devoted to them. Engineers and others who are interested in this matter should send for a copy of this catalogue, as it is valuable for reference.

"Variable Feed Lubricators" is the subject of a pamphlet issued by the Stirling Company, Rochester, N. Y. Many kinds of lubricators are illustrated and quite completely described, making a pamphlet that will be of much interest to engineers and others who have to do with lubrication. Copies of this pamphlet can be had upon application.

"Direct Current Multipolar Motors" is the subject matter of the bulletin, No. 1535, issued by the Bullock Electric Manufacturing Company, Cincinnati, Ohio. The bulletin comprises 16 pages, giving a very complete and detailed description of the motors and showing the manner in which they are connected to lathes, boring mills and other apparatus.

Monogram boilers and exhausters, catalogue No. 100, has proved so interesting that the B. F. Sturtevant Company, Jamaica Plain, Mass., has just issued a second edition. Like all of the Sturtevant publications, this one is very handsomely printed and contains many valuable tables, as well as much information regarding blowers and exhausters. Nearly one-half of the space in the fifty pages is devoted to fine engravings and illustrations.

Engines and launches manufactured by the Daimler Manufacturing Company, Steinway, Long Island City, N. Y., have a very handsome catalogue devoted to them. It is printed in colors and very finely illustrated, making it altogether an excellent example of printing. The engine is illustrated in many types, and a large number of illustrations are given of yachts and launches. An electric light plant operated by a Daimler engine is also illustrated and described. Altogether the catalogue is one of value to persons interested in small launches and yachts.

BUSINESS NOTES.

Magnolia Metal.—The announcement is made by the Q. & C. Company, Western Union Building, Chicago, that since October 16 last it has had the exclusive control of the selling of the Magnolia Antifriction Metal.

Hyde Windlasses.—The monster barge *Bath*, built by the New England Company, Bath, Maine, for the B. Line Transportation Company of Boston, is supplied with two steam windlass pumps furnished by the Hyde Windlass Company, Bath, Maine.

Gerdom's Grease.—Users of grease will be interested in the lubricants offered by the Gerdom-Kellogg Company, 6 Liberty St., Albany, N. Y. These greases are put up in a patent roll-up tube, by means of which every particle of the grease can be utilized without difficulty. The claim is made that "Gerdom's grease does not grip or gum, it greases."

Free Sample of Metal Polish.—In order to still further introduce the Keystone Metal Polish, John M. Watt's Sons, 136 Liberty street, New York, offer to send a free sample of the polish to any of our readers who will send for one, mentioning this magazine. This polish can be used equally well with all metals, and is especially adapted for hot or cold brass and steel.

To Fill Checks and Cracks.—There is so much cracking and checking of woodwork on yachts and vessels of all kinds that our readers will be much interested in the filler for this purpose which is manufactured and sold by the Grippin Manufacturing Company, Newark, New York. The claims for this filler are that it is easily any quickly applied and it will not sink, shrink, crack or crumble, and will make woodwork tight and water-proof; is tough, elastic and odorless when dry, and is easily and quickly applied to decks and seams.

Benton Marine Electrical Outfit.—In a letter to Thomas P. Benton & Son, La Crosse, Wis., Manager Troup, of the Columbian and Kootenay Steamboat Co., Nelson, B. C., says: "Your letter stating that you have shipped the 8F compound wound dynamo, with headlight, at hand. We are in need of this machine and are anxious to get it in place. This makes four of your No. 8F compound machines, with headlights, which we have purchased, one No. 6F, and one small machine, running headlight only. These machines have all given perfect satisfaction, and the simplicity of the outfits recommend them particularly to me. They are being run in charge of our engineers, none of whom have had the slightest experience with electric plants. Our watchmen soon become familiar with the adjustments of the headlights and attend to them without difficulty. The incandescent lights throughout our boats give good satisfaction, and for steamboat work, where a headlight is necessary for close navigation, and where a regular electrician is not at hand, I cannot recommend your machines too highly." The company recently ordered seven more complete outfits in addition to the above.

ZINC WHITE IN MARINE PAINTING.

Within a few years after the discovery of the modern process for making zinc white, the French naval authorities, after severe tests, ordered its use to the exclusion of white lead on the interior of all vessels of the French navy. Experience has confirmed its superiority for painting structures exposed to sea-air and sea-water, and the French navy as well as the French steamship companies now universally employ it, while it is also the official base for painting lighthouses and Government work on the seashore. The French marine authorities also use it for painting galvanized iron plates, the hulls of torpedo boats, the shells of metal pontoons, etc.

That the French navy should have been earliest to adopt this practice is natural, since zinc white was first generally introduced in France. But the naval authorities of the United States, having made their own experiments with the same results, have adopted zinc white as the fixed component of all paints used either in the Navy or by the Lighthouse Establishment. The famous "White Squadron" obtained its color from zinc white, and remained white because zinc does not change color. Ten tons of American zinc white is the cruising allotment for each ship, and it is used liberally and effectively.

Similar testimony is found in the U. S. Lighthouse specifications, which require, for white, a mixture of one-fourth lead and three-fourths zinc, and for tinted paints, American zinc white and yellow ochre, with no lead. "The colored paints are wanted for outside use and are required to withstand the bleaching effects of salt water and sunlight."

The durability of zinc white is due to its chemical stability and to the large proportion of oil it carries to the painted surface. No other white pigment approaches it in this respect. It is the one white paint material that is capable of resisting salt water and salt air. Added to other materials it shields them and gives them durability.

Advt. NEW JERSEY ZINC CO.

New Walworth Store.—The Walworth Manufacturing Company, Boston, Mass., will remove from its present quarters about December 1 to new quarters on Federal street, a short distance from the South Union Station. The new building is five stories, with a basement, and has every modern facility for carrying on business economically and expeditiously.

Advertising.—The Trade Paper Advertising Agency, 150 Nassau St., New York, has made an addition to its force in securing the services of Sam A. Elkington, who has been associated as advertising manager and advertising writer for the past ten years with leading journals of this country. He has had a wide experience in the field of technical work, and advertisers desirous of using trade papers will find his services of assistance and value to them. The agency will shortly open a branch office in Philadelphia for the convenience of its clients in that district, and this office will be in charge of Mr. Elkington.

HANCOCK INSPIRATORS.—The Hancock inspirator has until recently been manufactured by the Hancock Inspirator Company, but sold through parties who had the sole agency. This agency has now been terminated, and no one sells these inspirators except the company itself, which handles it direct with the trade. The company has recently issued a complete descriptive catalogue and price list, which will be mailed upon application by addressing the company, Watson street, Boston, Mass.

LONG BURNING ARC LAMPS.—One of the new arc lamps which has been offered for use in ship yards, on wharfs, and elsewhere where a long-burning and strong light is used, is the Toerring long-burning enclosed arc lamp manufactured by the Toerring Manufacturing Company, 1035 Ridge Ave., Philadelphia, Pa. The special features claimed for this lamp are ornamental design, simplicity of mechanism, long life (200 hours), ease of trimming, ease of adjustment, easy cleaning, and the general excellence of its con-

FLUE CLEANERS SENT ON TRIAL.—In order to more fully introduce the Niagara boiler tube cleaner, the Sherwood Manufacturing Company, Buffalo, N. Y., offers to send one of the flue cleaners to anybody on approval. The features claimed for this cleaner are that it consists of very few parts, which are made interchangeable, so that repairs can be furnished at a very low cost. No accessories are needed except a piece of steam hose, which is connected direct with the cleaner. A set of clamps for this purpose is sent with each cleaner. The Niagara cleaner is not a new and untried cleaner, as it has been on the market several years and is already in quite general use, both on the sea coast and on the Great Lakes. It can be operated either by steam or water.

BULLOCK ELECTRICAL APPARATUS.—The Bullock Electric Mfg. Co., Cincinnati, reports sales for the month involving sixty-one machines, ranging in size from three to 150 kilowatts. Among the more important were fifteen engine type generators for United States army transports, and ten 50 H.P. motors to operate at 200 R.P.M. for Messrs. Dick, Kerr & Co., of London, England. Several repeat orders were received, among them being one from the Maryland Steel Co., Baltimore, Md., third order. A new bulletin, No. 1535, just issued by the company, describes Type "N" motors. This is the first Bulletin of the standard 6 in. by 3 in. size which has been issued. Those of our readers interested in electrical literature will appreciate this reduction in size.

THE TROUT PROPELLER.—In putting this wheel on the market it has been the aim of the manufacturers to supply the demand for an efficient agent of propulsion, and they feel that they have met with a fair measure of success during their thirty years of experience. They do not attempt impossibilities; they change no existing conditions as to boiler capacity, model of vessel, or design or dimensions of machinery, but try to learn what they can accurately regarding these points, and build a wheel to work in harmony with them. They are always ready and willing to give advice on any of these points when asked, but usually find that the essential point on which to work is the adaptation of the wheel to meet existing conditions. To this end a question blank is sent to all patrons, which, when accurately filled out, gives the data on which to base calculations. They make their own designs, patterns, and castings in iron or brass, solid or sectional, and any diameter. These wheels are all bored and key-seated in their shop, to templates or wire gauges, and are shipped completed, ready to go on the shaft. Every description and dimension, of every wheel, is recorded, and every wheel they have ever made can be duplicated in every particular. Their trade extends from Maine to the Gulf, and to the Pacific Ocean, where they have recently sent a number of sectional wheels. Testimonials from patrons, or information relating to wheel performance, furnished on application by H. G. Trout, King Iron Works, 226 Ohio St., Buffalo, N. Y.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

REPAIRS TO THE S. S. MICHIGAN.—The Norwegian steamship *Michigan*, which recently grounded on the coast of Maine and was severely damaged, will be rebuilt by the Ross Iron Works, foot of Twenty-sixth street, South Brooklyn, N. Y.

TEST OF THE WATSON BOILER.—A test was made on September 20 last of a five horse power nominal Watson radial water tube boiler manufactured by Egbert P. Watson, Elizabeth, N. J. The duration of the test was 60 minutes, and the heating surface was 30 sq. ft., grate surface 1 sq. ft., weight on scales empty, 500 lbs. The results announced are as follows: Water evaporated on an average pressure of 110 lbs., 187 lbs. Water evaporated per pound of coal, 7.21. Water evaporated per sq. ft. of heating surface, 6 7-30 lbs. Fuel anthracite coal, stove size, and amount burned during the test, 26 lbs. Temperature of the feed water, 60 deg. Assisted draught, 1-4 in. valve on jet 1-4 turn open. Ash pit closed tight. This test was made without any preliminary preparations, and immediately after soft coal had been used.

CYLINDER PACKING ON THE MARY POWELL.—The captain of the famous river boat, *Mary Powell*, recently wrote to the manufacturers of St. John cylinder packing as follows: "This packing has been used on the *Mary Powell* for the past three seasons, and has given perfect satisfaction. We find that it pays for itself every season in the saving of coal, and our season is only five months. Our cylinder is 72 inches, stroke of piston 12 feet." It is claimed for the St. John packing by the makers that it makes a perfectly tight piston, with a minimum of friction, and being almost self-lubricating, saves eighty per cent in cylinder oil. It saves ten per cent and upward in fuel, or gives a corresponding increase of power. It retains cylinder round and true, thus rendering reboring unnecessary; and, being perfectly self-adjusting, saves the engineer the time and trouble of setting out springs. It is held evenly against the cylinder it moves in, and there is no wabbling motion to the piston, but it traverses the cylinder with a smooth, steady and always central movement. This packing is manufactured by the St. John Cylinder Packing Co., 108 Fulton St., New York.

PITTING.—This is the title of a circular just issued which says: "Pitting is a corrosion of the plates and rivets of the boiler, mostly occurring in the bottom of the boiler, on account of lack of circulation. This corrosion attacks steel much more rapidly than iron, and only seems to occur in connection with the use of a surface condenser. It is probably caused by the impurities of the water becoming concentrated by evaporation and the loss of air in condensation, together with acids absorbed from the oils by steam, in passing through the engine and the contact with the brass tubes of condenser and copper feed pipes. This water after being used over and over again becomes highly concentrated, like acid, and much heavier than fresh water, consequently it settles to the bottom of the boiler, the fresh water remaining at the top. But by creating a thorough circulation of the water in boiler this water is kept mixed with the fresh water at top and the corrosive action is neutralized. A liberal use of zinc plates scattered through the water spaces has the effect of transferring a portion of this corrosion to the zinc instead of the boiler plates, thus greatly reducing the trouble, especially if boiler has only an intermittent service, as the action continues much more rapidly while boiler is out of service."

TRADE PUBLICATIONS.

An eight-page folder with cover is issued by the Rushmore Dynamo Works, Jersey City, N. J., giving a list of the yachts and vessels which are equipped with Rushmore projectors.

Several specialties of the National Lead Company, 100 William street, New York, are well described in the eight-page folder just issued. These specialties include the various products of lead, metals for bearings, etc.

Users of drilling compound will be interested in the little folder issued by the White & Bagley Company, Worcester, Mass., describing the economy drilling compound, and giving quite a little information regarding it.

"Amyline is a chemical preparation applied with a brush for removing paint and varnish by one application." In a pamphlet just issued by the manufacturers, the Wilson Company, 11 Broadway, New York, this paste is described.

Lozier gas engines, manufactured by H. A. Lozier & Co., Cleveland, Ohio, are described quite thoroughly in a catalogue which will be sent to all inquirers. Several pictures of the engines are given, and the different sizes built are described.

Lackawana Lubricators have a complete catalogue devoted to them, issued by the manufacturers, the Lackawana Lubricator & Manufacturing Co., Scranton, Pa. Illustrations are given of the Lackawana improved grease cup and cylinder lubricator, and several testimonials are given.

Veeder ratchet counters manufactured by the Veeder Mfg. Co., Hartford, Conn., have three different illustrations and descriptions in a four-page folder. These counters are very compact and designed to count up to 99,999, and can be used in any position. As the price is only one dollar undoubtedly many of our readers will be interested.

Peerless gas and gasoline engines manufactured by the Clark Mfg. Co., Fond du Lac, Wis., are described in a four-page circular sent to all who are interested. The circular gives quite an amount of information regarding the marine type of engine with prices for smaller sizes.

Rumsey's Power Pumps is the title of a ninety-six page neatly printed catalogue issued by Rumsey & Co., Ltd., Seneca Falls, N. Y. The many types of pumps are illustrated and fully described, and include pumps for all uses. Particular attention is devoted to centrifugal pumps of many kinds, but there are also boiler feed pumps, fire and force pumps, rotary pumps, triplex pumps, etc.

The single bell quartet chime whistle manufactured by the Kinsley Mfg. Co., Bridgeport, Conn., is fully described in a pocket size catalogue. This whistle has become very popular among yachtsmen because of the quality of its tones, which, as stated in the catalogue, are pitched to a "musical scale." Several highly complimentary testimonials are given. Copies of the catalogue will be sent on inquiry.

The fifty-second edition of the general catalogue of pumps and hydraulic apparatus manufactured by Rumsey & Company, Limited, Seneca Falls, N. Y., is just out and is a very compact one, 4 by 6 in. in size, well printed on fine paper, comprising 192 pages and containing many illustrations. It describes a full line of pumps of all kinds, such as bilge pumps, cistern pumps, force pumps, suction pumps, double-acting pumps, diaphragm pumps, etc.

Users of gas engines will be interested in an eight-page folder issued by the Lake Shore Engine Works, Marquette, Mich., illustrating and describing the "Superior" gas and gasoline engine. Three different views of the engine are shown, and tables are published giving complete details of the single cylinder, double cylinder and triple cylinder. A number of testimonials are also given speaking in high terms of the engines by many users of it.

Foster's Fog Signals are described in an eight-page folder issued by C. A. Hamilton, 71 Broadway, New York. The text tells the manner for determining the position of vessels and lighthouses in thick weather by this system. A working model is on exhibition at the office.

Aspinall's patent governor, which is made in Europe, is handled in the United States by Thorpe, Platt & Co., 97 Cedar street, New York, who have a catalogue describing it now ready for distribution. The catalogue is well illustrated, showing the manner in which the governor is applied to engines of different types. The claim is made for the device that it is exceedingly simple and can be applied with ease, requiring no special attention or preparation in the design of the engine.

Drawing instruments and other draftsmen's supplies manufactured by Theodore Alteneder & Sons, 945 Ridge avenue, Philadelphia, Pa., have a very handsome catalogue devoted to them, which is the eighteenth edition. There are over a hundred pages describing a full line of supplies, and the printing is exceptionally neat, being in two colors. An index at the back of the book adds very much to its value. Every draftsman should send for a copy, as the completeness of the catalogue makes it very desirable for purposes of reference.

The International Pneumatic Tool Co., Ltd., Palace Chamber, 9 Bridge street, Westminster, S. W., London, England, sends us a very handsome catalogue of the "Little Giant" pneumatic tools of all kinds. This company recently purchased all the foreign rights of the Standard Pneumatic Tool Co., of Chicago. Among the tools illustrated and described are piston air drills, boring machines, hammers, staybolt cutters, flue rolling machines, riveters, hoists, jacks, etc. It is a very valuable book for reference on the subject of pneumatic tools.

Modern Improved Marine Railways is the title of a catalogue issued by H. I. Crandall & Son, East Boston, Mass. This concern devotes itself exclusively to the construction of marine railways, and a number of illustrations are given of railways which have been constructed. The subject of the power plant for such use is fully covered, and a large engraving is given of the machinery used. The firm already has railways along the Atlantic coast, and there are many in Canada. The catalogue is a valuable one for reference to anyone who contemplates building a marine railway or who already has one in operation.

Harthan's metallic rod packing is fully described in a pocket size catalogue issued by the Reeves Machine Co., Trenton, N. J. This packing has been in use for several years, but has only recently been taken hold of by the new owners. It is finely illustrated in the catalogue, and is as fully described as would be necessary to give a complete understanding regarding it. Special claims for the packing are that it is not used in combination with other materials, is simple, inexpensive, can be used for any purpose where packing is required, is made on scientific principles and can be applied by anyone who knows what packing is. Copies of the catalogue are now ready for distribution.

Many readers interested in electricity will want to send for copies of the two books just issued by the publication department of the Westinghouse Companies, Pittsburg, Pa. One of them describes railway motors, and is a superb specimen of catalogue making. It contains a great deal of valuable information, and has many illustrations of the use of electricity in railway work, showing the motors used as well as the electric plants. The other book is devoted to the Westinghouse electro-pneumatic system for controlling railway and other motors. It is, if possible, a finer specimen of catalogue making. The illustrations are very complete, and much attention is devoted to the so-called third rail system for running cars.

BUSINESS NOTES.

Portable Forges.—The portable forges manufactured by the Empire Forge Co., Lansingburgh, N. Y., are being extensively introduced in ship yards and elsewhere. The New York sales agents are Hendricks & Class, 150 Nassau street.

Sand Blast for Cleaning Hulls.—Many of our readers will be interested in the advertisement of Edgar T. Ward & Sons, 25 Purchase street, Boston, Mass. The sand blast has been tried for cleaning hulls, and has proved itself of economic value for this purpose.

The Knickerbocker Engine.—One of the newer engines on the market which can be used in almost any position is the Knickerbocker, manufactured by the Knickerbocker Engine Co., Hartford, Conn. This engine can be operated either by steam or compressed air. It has been used for some time on quite a number of launches and small yachts for purposes of propulsion, and has also been used for direct-connected electric work, etc.

Dry Dock Pumps.—It is announced that the order for pumps to be used in the new dry dock at the Boston Navy Yard has been awarded to the Prindle Pump Co., 122 Liberty street, New York. It is understood that there are three centrifugal pumps, which are to have a capacity of 35,000 gallons a minute. The electrical part of the contract is reported to have been placed with the Westinghouse Electric & Manufacturing Co., Pittsburgh.

A Souvenir Packing Tool.—The Mound Tool and Scraper Co., 712 Howard street, St. Louis, Mo., manufactures a line of scraping tools for engineers, together with special tools for removing packing from stuffing boxes, etc. All purchasers of tools or other goods from this company during the month of December will receive a present of a souvenir packing tool with their orders. Circulars and full information regarding the many tools of this concern can be had upon application.

Valve Reseating Machines.—The Morse and Dexter Valve Reseating Machine has proved itself very valuable in repairing all flat and conical seated valves and faucets without disconnecting them from the pipes. These machines are used not only in the United States Navy, but by several navies in Europe, and by leading marine people, such as the Bath Iron Works, Cramps, Newport News Yard, Union Iron Works, and many other shipyards, together with the leading steamships along the Atlantic coast, as well as on the great lakes. So confident is the manufacturer of the value of these machines that it will ship one to responsible concerns with the distinct understanding that the outfit con be returned at the manufacturer's expense at the end of thirty days if it does not give entire satisfaction. The address of the manufacturers is the Leavitt Machine Co., Orange, Mass.

Steam Specialties.—Every engineer will be interested in the line of steam specialties shown in the advertisement of the Sherwood Mfg. Co., Buffalo, N. Y. This company makes lubricators of all kinds, injectors, flue cleaners, etc.

A Thriving Boat Business.—Palmer Bros., Mianus, Conn., have enlarged their factory, and for some weeks have had a full force of boat builders at work building launches of standard sizes. The firm will lay in as large a stock as possible, so as to be in shape to fill all orders promptly as soon as the yachting season begins next spring.

Marine Forgings.—The Delaney Forge & Iron Co., Buffalo, N. Y., has added to its plant a seven-ton upright steam hammer, built by Bement, Miles & Co., of Philadelphia, and a 6,000 lb. helve hammer. With these and other additions to the facilities for doing work, the company has a capacity of from 35,000 to 45,000 lb. of forgings per day, and is fitted up to do anything in the line of marine forgings.

Test of Ball Bearing Sheaves.—A severe test was recently made by officials of the navy on sheaves of different kinds, one of the sheaves being a 31-2 in. Parkin ball bearing with a 1-2 in. pin, each block carrying 248 lb., and the sheaves were not oiled. Other sheaves became hot and stopped turning in a few minutes, but the report says there was no trouble with the Parkin bushing. Later on a test was made of bushings immersed in sea water for 24 hours and exposed to the weather for six days, then oiled without cleaning, and it ran for several days without friction. The result of this test was that the recommendation was made that the Parkin ball bearing sheave wheels be used in the navy. These wheels are manufactured by the Pennsylvania Block Co., 2049 North Second street, Philadelphia, Pa.

Electric Search Lights.—The Carlisle & Finch Co., Cincinnati, Ohio, is exceptionally busy filling orders for search lights and marine projectors. It reports large orders from all over the United States and Canada. Recently shipments have been made of five 19 in. projectors to one of the large steel companies at Youngstown, Ohio; several lights to the new Monongahela C. C. Co., of Pittsburgh, Pa.; a large deck projector to Victoria, B. C.; one of the latest type pilot house projectors to San Francisco, Cal. The 9 in. projectors of this manufacture are meeting with a large sale among the owners of yachts and launches. A number of them have recently been purchased for use on naphtha and gasoline launches. It is claimed by this company that no steamboat on the Ohio river has been supplied with any other make of search light for two years past. The Carlisle & Finch Co. will be glad to furnish catalogues and prices to all interested. Its search lights and projectors are sold by the Newman-Spranley Co., 330 Baronne street, New Orleans, La.; the Badt-Goltz Engineering Co., Monadnock Block, Chicago; Wybro-Hendy Co., 38 Fremont street, San Francisco, Cal.

MAGNOLIA ANTI-FRICTION METAL.—The Q. & C. Co., Western Union Building, Chicago, and corner of Liberty and Church streets, New York, announces that it has taken control of the selling of the Magnolia Anti-Friction Metal for the railroad trade.

VENTILATING AND HEATING STEAMSHIPS.—A very interesting publication is issued by the B. F. Sturtevant Co., Jamaica Plain, Mass., giving a very complete description with illustrations of the system of ventilating and heating on the steamships *St. Louis* and *St. Paul*.

STEEL FORGINGS.—Owing to the great demand for steel forgings for new vessels to be built in all parts of the country, the Bethlehem Steel Co., South Bethlehem, Pa., has been pushed with orders. This company has furnished some very fine forgings for the Russian war vessels at the Cramps yard, and many of the large steamships being operated on the lakes have Bethlehem forgings.

TOOLS AND SUPPLIES.—Charles H. Besly & Co., 10 and 12 North Canal street, Chicago, Ill., report large demands for machinists' tools and supplies, shipments being made to all parts of the United States and Canada. On Helmet Oil, Perfection and Bonanza Cups, contracts have already been closed for future delivery far in excess of any former years. Their factory at Beloit, Wis., is being run overtime in many departments to supply the demands for their specialties, which are not only being sold in this country, but among foreign countries. Recently shipments have been made to India, Argentina, France, Germany, Russia and England. Messrs. Besly & Co. are introducing a new machine known as the Gardner band grinder, and would be pleased to answer queries or submit descriptive matter upon application.

THE EFFECT OF CIRCULATION.—A recent catalogue says: "Owing to the movement of the water from one place to another, the whole body of water becomes heated to an even temperature in all parts of the boiler, due to each particle of water coming in contact with the heating surfaces. With a poor circulation, a certain amount of the water lies dead at the bottom of boiler, remaining at a low temperature, thus being detrimental to the efficiency of the boiler. But on the contrary, when this water is kept at a high temperature it is a distinct advantage, as increasing the capacity of boiler for storing up heat to be utilized during fluctuations in the demand for steam. The effect of this dead water is more noticeable where boilers have banked fires for several hours at a time, and then only making a short run of half an hour to an hour, as in the case of tug boats handling vessels around wharves. In such cases this dead water cools down very much while lying idle, and the service is too short to start up much of a circulation. But with some artificial means of creating a circulation this dead water becomes heated very rapidly, and the boiler shows a remarkable increase in efficiency."

ENGINES FOR BLOWER WORK.—W. D. Forbes & Co., Hoboken, N. J., have recently received a large number of orders for engines for blowers, not only for use in the navy and merchant marine in this country, but for use in foreign navies.

CAPS AND UNIFORMS.—The Warnock Uniform Co., 19 West Thirty-first street, New York, makes a specialty of caps and uniforms and all kinds of goods for yachting and other uses.

BULLOCK ELECTRIC MACHINES.—The Bullock Electric Mfg. Co., Cincinnati, Ohio, reports 55 orders within four weeks lately for machines from the smallest size up to 300 K.W. One of the largest orders was from the Maryland Steel Co., making the fifth order from this company, and it called for several motors in addition to a large generator. Orders were also received from England and Russia, as well as other parts of the world.

WEDGE PACKING.—John M. Watts' Sons, 136 Liberty street, N. Y., report a very large demand for their wedge packing. This packing is made of fine materials which, with the formation of wedges and lubricants, makes it an elastic and durable packing. Special claim is made that it cannot become hard and that it cannot cut or gum the rods. The manufacturers offer to send a sample on trial to any responsible party, and if the claims made are not substantiated no charge will be made.

MARINE ENGINES.—The Frontier Engine Works, foot of Illinois street, Buffalo, N. Y., have placed on the market a line of marine engines and are making a specialty of repair work.

PACKING.—Attention is called to the advertisement elsewhere of A. W. Chesterton & Co., 49 India street, Boston, Mass. This firm makes a full line of packings for all uses, for high-pressure as well as for auxiliaries.

PRATT CHUCKS.—Owing to the great increase in its business, the Pratt Chuck Co., Frankfort, N. Y., has found it necessary to rebuild and increase its plant in order to accommodate the largely increased force of men. This company's business not only extends throughout the United States, but one of the largest orders ever received came recently from a shipbuilding concern on the Clyde.

STEEL STAYBOLTS.—A test was recently made of staybolts manufactured by the Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio, with these results: original dimensions, 1.035; area, .8179; dimensions after fracture, .645; area, .3029; elastic limit, 30,600 lb.; maximum load, 47,700; elastic limit, 37,410 lb. per sq. in.; tensile strength, 58,320 lb. per sq. in.; elongation in eight inches, 2.60; per cent, 32.5; reduction of area per cent, 63.0; fracture, silky. The company announces the recent receipt of a large order from the Neafie & Levy Ship and Engine Building Co., Philadelphia; also an order to supply the staybolts for seventy-five locomotives.

STOKERS FOR MARINE FURNACES.—The American Stoker Co., New York, is meeting with success evidently with its automatic stoker on board ship, and has issued a circular setting forth the advantages of the stoker. The Government recently had exhaustive tests made of the stokers which were put under the Babcock & Wilcox boilers on the Lake S.S. *Pennsylvania*. Two more vessels of the same type are now being equipped. It might be of interest to note some of the results of the tests, which were made by the Government engineers, Lieutenants B. C. Bryan and W. W. White, of the United States navy. The boilers (two) were 250 H. P. each. At the four trials the engines developed an indicated H. P. average of 1,173, the coal used was slack, and costs sixty cents per ton less than run-of-mine. With this coal, evaporation was reported to have been obtained equal to The run-of-mine coal, under hand firing conditions. The vessel is of 10,155 tons displacement, and was run at an average speed loaded of 10.8 knots. She burned 200 tons per trip, and made twenty-two trips this season. Besides the reduction in coal bills, brought about by the use of the stokers, the absence of smoke figured as a large factor. The smoke nuisance is being fought by Boards of Health, Merchants' Associations, and other organizations in various cities. All sorts of devices for smoke prevention are being tried to offset the evil, and the American Stoker Co. believes that it has reached a solution of the smoke problem. The stokers were not designed primarily as smoke preventing machines. Their greatest value lies in their doing away with hand firing, and the claim is made that combustion is practically perfect, resulting in economy of fuel. One efficient man can attend to a great many stokers, and the work of handling coal can be done by coal passers. The great objection heretofore to adopting stokers on board ship has been the fact that when they would be most needed at sea something might happen to their mechanism to render them useless, but with the American Stoker the mechanism is too simple to be easily disarranged, and if this should happen hand firing can be resorted to on a minute's notice. The stokers are easily regulated, and dead fires may be kept indefinitely. Full information regarding the installation on the *Pennsylvania* and special marine circulars can be had upon application to the American Stoker Co., 141 Broadway, New York.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

A NEW ALUMINUM PAINT.—A new paint specially desirable for marine work is being introduced by L. H. Austen & Co., 52 Beaver street, New York. This paint is called "Lustrogen," and is an aluminum paint that dries within a short time. The claims for the paint are that it is waterproof, and that it is not injured by salt air, making it especially desirable for marine work.

KENNY FLUSHOMETER.—The Kenny Co., 72-74 Trinity place, New York, the manufacturer of the well-known Kenny Flushometer, received the following letter lately from J. H. Sheadle, secretary of the Cleveland-Cliffs Iron Co.: "In looking over a new ship, the steamer *Angeline*, that we have just received from the Detroit Shipbuilding Co., I was much pleased to note what seemed to be a very excellent steamboat closet, called the Flushometer. I would like very much if you would send me a catalogue with prices of these closets. . . . Every now and then there are some of the closets on our vessels giving way, and this one seems to be of some value—the first one, in fact, that I ever saw that was."

ADVERTISING AGENCY.—To make advertising pay it must receive more time, thought and attention than the busy manufacturer of to-day can usually give it. The situation draws timely attention to the Manufacturers' Advertising Bureau, New York, and the aid it extends in this direction. This concern was established more than twenty years ago by Benjamin R. Western, the original and present proprietor. It makes a specialty of mediums of a technical and trade character. That its methods are attractive is proved in the steady additions to its list of clients, among whom are to be noted recently the American Stoker Co., Adam Cook's Sons, and Manning, Maxwell & Moore, of New York, with its kindred interests; the Ashcroft Mfg. Co., the Hayden & Derby Mfg. Co., the Pedrick & Ayer Co., the Consolidated Safety Valve Co., and the Shaw Electric Crane Co. A booklet is issued by the bureau, bearing the title, "Advertising for Profit." Copies may be had upon application.

Penn Steel Casting Co.—Because of the great demand for its castings, the Penn Steel Casting Company, Chester, Pa., has been obliged to increase the facilities of its machine shop. There is such a rush of work that the machinery was installed in the new shop even before the roofs were completed.

Large Business in Propellers.—We are informed by the Sheriffs Mfg. Co., Milwaukee, Wis., that from January 1 to November 15 inclusive, 135 propellers were made and sold. Of these, 113 were made on order, the balance were in stock. The average time for making the wheels was 2⅛ days, including Sundays, and the diameter of the wheels ranged from 12 ft. 6 in. to 15 ft., and 90 per cent of them were bored and key-seated.

Complete Pneumatic Plant.—The American Ship Windlass Company, Providence, R. I., is installing a very complete plant for pneumatic tools. The plant comprises a complete compressed air tool outfit installed by the Clayton Air Compressor Company, 26 Cortlandt street, New York. Besides the air compressor and air receiver the Ship Windlass Company will have a full line of pneumatic tools, such as calking and chipping tools, drills, hoists, etc.

Marine Chronometers.—The business of selling and caring for chronometers, which was well established by H. H. Heinrich, has recently been purchased by C. A. Geissler, who has taken the old quarters at 102 Fulton street, New York. Mr. Geissler makes a specialty of chronometers of high grade, and also does adjusting and repairing. He also has in stock second-hand ones, which he guarantees. Mr. Geissler has supplied many chronometers for the navy and for the transport service, and has the regular care of the chronometers for leading steamship lines in the transatlantic and coastwise services. Another branch of his business is selling and regulating exact watches.

Metallic Flexible Tubing.—Users of rubber hose will be interested in a metallic tubing which is manufactured by the Metallic Flexible Tubing Co., 256 South Second street, Philadelphia, Pa. This tubing is designed for any use where hose is used, and the claim is made for it that 1,000 lb. pressure to the sq. in. will not burst it. This makes the hose very desirable for compressed air uses as well as for anything where strong hose is desired. The armor is sold separate whenever so wanted. It has great durability and flexibility, and is designed to prevent bursting, kinking and mashing of the hose. It also prevents exterior wear. It can be applied to the outside as well as to the inside of the hose. Samples are sent to all inquirers who wish to make a test.

"Little Giant" Pneumatic Tools.—Special attention is called to the complete line of pneumatic tools offered by the Standard Pneumatic Tool Company, Marquette Building, Chicago. These are all named "Little Giant." Among the special features claimed for them is economy in the use of air, lightness of weight and simplicity of construction. The tools are small and compact, easily handled and operated and made entirely of steel. The drills and boring machines are of the piston type, have double balanced piston valves which cut off at 5-8 of full stroke, and can be operated in a bath of oil, as the exhaust does not come in contact with working parts. The hammers are especially adapted for chipping, calking, beading, etc., and are manufactured in all sizes to meet requirements. The company will send any of its tools on trial with the understanding that they can be returned without expense if they do not give entire satisfaction. A guarantee is also given against repair for one year. That these tools are not an experiment is evidenced by the fact that they have been adopted by a great many ship yards, boiler shops, railroads, foundries, architectural iron works, United States Navy yards, bridge and other contractors throughout the world.

4-2